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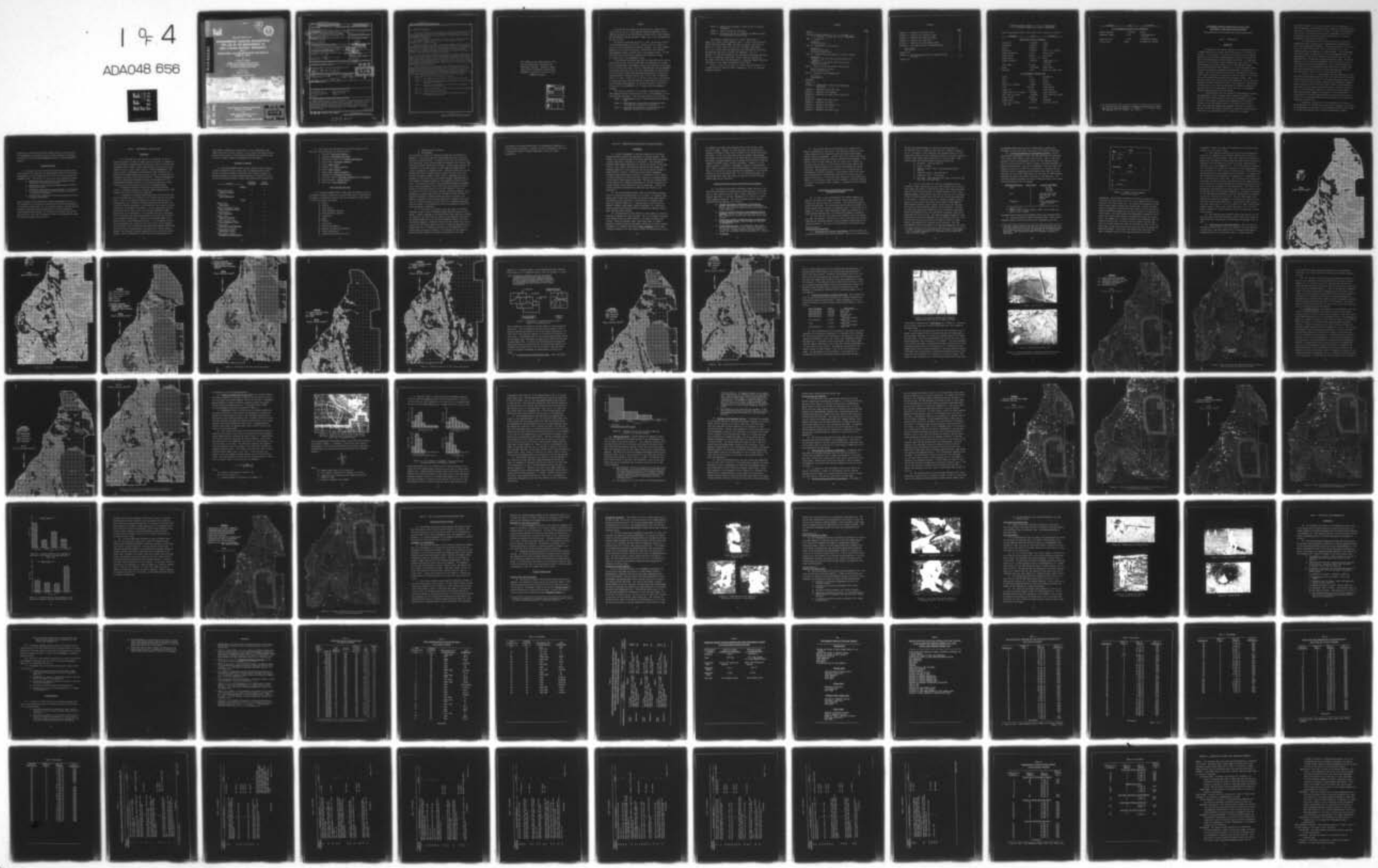

TECHNICAL REPORT M-77-4

ENVIRONMENTAL BASELINE DESCRIPTIONS FOR USE IN THE MANAGEMENT OF FORT CARSON NATURAL RESOURCES

Report I

DEVELOPMENT AND USE OF WILDLIFE AND WILDLIFE HABITAT DATA

by

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Report I of a Series

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Environmental protection and enhancement of the natural resources of Army installations has become an integral part of the design, construction, operation, and maintenance activities on those installations. In 1975, the U. S. Army Engineer Waterways Experiment Station (WES) began a study to provide environmental baseline descriptions for use in the management of Fort Carson natural resources.

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20. ~~ABSTRACT (Continued).~~

The overall objective of the study was to demonstrate environmental baseline methodologies and to use these methodologies and procedures to collect environmental baseline data that were pertinent to the Fort Carson Long Range Environmental Program.

This report presents the detailed environmental data collected on wildlife and wildlife habitats at Fort Carson, Colorado, during the period 1 August 1975 to 1 March 1977.

Narrative accounts on 13 animal species were prepared from the wildlife literature and information obtained from state and Federal wildlife biologists. The narrative accounts contain data on the habits and habitat requirements of the mule deer, pronghorn, black-tailed prairie dog, scaled quail, bobcat, mountain lion, coyote, golden eagle, mourning dove, cottontail rabbit, Abert's squirrel, black bear, and the black-footed ferret.

A conceptual habitat identification and mapping procedure is described. Application of the procedure to the identification and mapping of black-tailed prairie dog habitat resulted in data showing that 70,000 acres of Fort Carson (52 percent) were potential habitats for the prairie dog. Forty of 43 (93 percent) existing and abandoned prairie dog towns were identified within the areas designated as potential habitat areas. Examples of use of the narrative account and habitat data are presented.

The procedure could not be applied to the identification of potential habitats of the mule deer within the time frame of the study because the literature search for the habitat requirements of the deer did not yield sufficient quantitative data to permit the establishment of practical mapping criteria. A study to further define the habitat requirements of and the effects of military range training operations on the mule deer is recommended.

This report is the first of six reports as follows:

Report 1: Development and Use of Wildlife and Wildlife Habitat Data

Report 2: Water-Quality, Meteorologic, and Hydrologic Data Collected with Automated Field Stations

Report 3: Inventory and Assessment of Current Methods for Rangeland Conservation and Restoration

Report 4: Analysis and Assessment of Soil Erosion in Selected Watersheds

Report 5: General Geology and Seismicity

Report 6: Description and Use of a Computer Information System for Environmental Baseline Data

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PREFACE

The study reported herein was conducted from 1 August 1975 to 1 March 1977 at the U. S. Army Engineer Waterways Experiment Station (WES) by personnel of the Environmental Systems Division (ESD), Mobility and Environmental Systems Laboratory (MESL), and of the Instrumentation Services Division.

The work was authorized by LTC E. R. Hall, Directorate of Facilities and Engineering, Fort Carson, Colorado, and is in support of the Fort Carson Long-Range Environmental Program. The overall Program Managers at Fort Carson were Messrs. Durwood Davis (now retired), Land Management Branch, and Mike Halla, Environmental Office. The WES work relating to wildlife and vegetation was conducted through Mr. Gaylord Bober, Land Management Branch.

The procedures and methodology used for acquiring on-site environmental baseline data were developed under the Department of the Army Project 4A162121A896, "Environmental Quality for Construction and Operation of Military Facilities," Task 01, "Environmental Quality Management of Military Facilities," Work Unit 006, "Methodology for Characterization of Military Installations Environmental Baselines," sponsored by the Directorate of Military Construction, Office, Chief of Engineers (OCE), U. S. Army. Partial cost of the Fort Carson work that pertained to collecting on-site baseline data was assumed under the auspices of the OCE program mentioned above as research necessary to assess the reliability of the procedures used to support Facility Management Programs.

This report is the first of six reports collectively entitled "Environmental Baseline Descriptions for Use in the Management of Fort Carson Natural Resources." The individual reports are as follows:

Report 1: Development and Use of Wildlife and Wildlife Habitat Data

Report 2: Water-Quality, Meteorologic, and Hydrologic Data Collected with Automated Field Stations

Report 3: Inventory and Assessment of Current Methods for Rangeland Conservation and Restoration

Report 4: Analysis and Assessment of Soil Erosion in Selected Watersheds

Report 5: General Geology and Seismicity

Report 6: Description and Use of a Computer Information System for Environmental Baseline Data.

The study was conducted under the direct supervision of Messrs. H. W. West, Project Engineer, and J. K. Stoll, Chief, Environmental Simulation Branch (ESB), and under the general supervision of Messrs. B. O. Benn, Chief, ESD, and W. G. Shockley, Chief, MESL. Mr. A. M. B. Rekas, ESB, was responsible for collecting the field data and analyzing the data on wildlife and vegetation. Mr. E. A. Dardeau, Jr., ESB, was responsible for gathering and analyzing the data on soils, topography, and geology. Messrs. Rekas and Dardeau and Ms. Jeanne Jones, ESB, were responsible for preparing wildlife narrative descriptions. This report was prepared by Mr. Rekas.

COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of the WES during the study and report preparation. Mr. F. R. Brown was Technical Director.

CONTENTS

CONTENTS

CONVERSION FACTORS, METRIC (SI) TO U. S. CUSTOMARY AND
U. S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

Units of measurement used in this report can be converted as follows:

Multiply	By	To Obtain
Metric (SI) to U. S. Customary		
millimetres	0.03937007	inches
centimetres	0.3937007	inches
metres	3.280839	feet
kilometres	0.6213711	miles (U. S. statute)
square centimetres	0.1550	square inches
square metres	10.76391	square feet
square metres	2.47105×10^{-4}	acres
square kilometres	0.3861021	square miles (U. S. statute)
cubic metres	35.31466	cubic feet
grams	0.002204622	pound (mass)
millibars	0.0145	pounds per square foot
U. S. Customary to Metric (SI)		
inches	25.4	millimetres
feet	0.3048	metres
yards	0.9144	metres
miles (U. S. statute)	1.609344	kilometres
acres	4046.856	square metres
square rod	25.292	square metres
square miles (U. S. statute)	2.589988	square kilometres
cubic feet per second	0.02831685	cubic metres per second
ounces (mass)	28.34952	grams
pounds (mass)	0.4535924	kilograms
miles (U. S. statute) per hour	0.44704	metres per second

(Continued)

Multiply	By	To Obtain
U. S. Customary to Metric (SI) (Concluded)		
degrees (angular)	0.01745329	radians
Fahrenheit degrees	0.555	Celsius degrees or Kelvins*
pounds per acre	1.128	kilograms per hectare
tons per acre	2256.0	kilograms per hectare

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: C = 0.555(F - 32). To obtain Kelvin (K) readings, use: K = 0.555(F - 32) + 273.15.

ENVIRONMENTAL BASELINE DESCRIPTIONS FOR USE IN THE MANAGEMENT OF FORT CARSON NATURAL RESOURCES

DEVELOPMENT AND USE OF WILDLIFE AND WILDLIFE HABITAT DATA

PART I: INTRODUCTION

Background

1. Management of the natural resources of an Army installation is a complex process that involves the reconciliation of two primary objectives. One objective is the need to use the area for the purposes for which it was intended, including weapons firing, vehicle maneuvering, troop bivouacking, and other military activities. If these purposes are to be fulfilled, men and machines must move across or live on the landscape for varying periods of time, thus imposing certain inevitable pressures on that landscape, i.e., plant and animal populations are disturbed and topographic and hydrologic conditions are altered. The second objective is the desire to maintain the installation's natural resources in as natural a state as possible, or at least in a state aesthetically pleasing and ecologically viable. Many military reservations contain within their boundaries some of the finest wildlife and native conservation areas in their regions. Nevertheless, increased use of some areas and the desire to prevent the mistakes of the past have led to a requirement for far more skillful management practices than have previously been needed.

2. Army Regulation (AR) 200-1 entitled "Environmental Protection and Enhancement," dated 7 December 1973, implements Department of Defense Directive 5100.50 and provides general Department of the Army policy on environmental protection and enhancement of the natural resources of all Army installations in the United States and overseas. The long-term planning and management objectives outlined in AR 200-1 require that design, construction, operation, and maintenance activities on an installation must be conducted with minimum

environmental impact on the natural resources of the installation. A Corps of Engineers study entitled "Study of Impact of Environmental Consideration on Military Construction," dated 1 November 1970, emphasized the need for "a system providing necessary technology to support the environmental decision making processes associated with life-cycle management of Army military facilities."

3. The Environmental Office of the Directorate of Facilities Engineering (DFAE) is responsible for implementing and managing the Fort Carson Environmental Program.[1] The program consists of air, water, noise, and radiation pollution control; solid waste, toxic, and hazardous materials management; and land management. The Land Management Branch, DFAE, is responsible for two land management plans: the Land Management Plan for the cantonment area, and the Land Use and Management Plan for downrange training and maneuver areas. The overall objective of the Land Use and Management Plan is to provide a plan for coordinating the wildlife management and soil and water conservation activities of the Land Management Branch, DFAE, with the range firing and troop training activities of the Plans and Operations Division, Assistant Chief of Staff, Director of Plans and Training.

4. In 1974, the U. S. Army Engineer Waterways Experiment Station (WES) began testing methodologies at Fort Carson that had been developed to apply airborne remote sensors to acquiring environmental data in the field. This effort was directed toward detecting and mapping damage to surface vegetation due to vehicular traffic during training maneuvers. The results of this study provided data needed to schedule training in areas of lowest vehicular usage and to identify the areas subject to severe environmental damage, as documented in a recent WES report.[2] A second phase of fieldwork--demonstrating ground data collection techniques for defining environmental baseline conditions--was completed by a WES team in August 1975.

5. During the second phase of the fieldwork at Fort Carson, it became apparent that the WES could provide direct support to Fort Carson in the generation of information and environmental baseline data needed to develop and implement the Fort Carson Environmental Program.

Specifically, the WES could provide baseline data for use in the wildlife management, water-quality control, range assessment, restoration and erosion control, and land management portions of the Environmental Program.

Purpose and Scope

6. The purpose of the work reported herein was to provide technical support (i.e. basic data and methodology) needed for the effective implementation of the wildlife portion of the Fort Carson Land Use and Management Plan. This portion of the plan has the following objectives:

- a. Identification and protection of any endangered animal species and their associated habitats.
- b. Description of native game and nongame animals and their associated habitats.
- c. Restoration, improvement, and preservation of the habitats of any wildlife species that have aesthetic, scientific, or ecological significance.
- d. Reduction and elimination of wildlife populations that are considered undesirable.

Work in support of these objectives included development and use of: (a) procedures used to describe wildlife and their habitat requirements in narrative accounts (Part II), (b) procedures used to identify and map potential wildlife habitats and application of these procedures to identifying potential habitats of the black-tailed prairie dog and the mule deer (Part III), and (c) examples of uses of the narrative accounts and potential habitat data (Part IV).

PART II: DEVELOPMENT OF WILDLIFE DATA

Background

7. In this study the term "habitat" is considered to denote a spatial environment in which an animal species lives and all elements of that environment, including land and water area, physical structure and topography, flora, fauna, climate, human activity, and the quality and chemical content of soil, water, and air. Wildlife management is the science and art of changing the characteristics and interactions of habitats, wild animal populations, and men in order to achieve specific human goals by means of the wildlife resource.[3] Wildlife management on a military installation ultimately involves the manipulation of the complex man-land-animal triad and, to be effective, must have a prominent place in the installation's land use and management plan.

8. Management techniques that can be used with predictable results to increase, decrease, or stabilize animal populations are being sought by the Fort Carson Facilities Engineer.

9. Techniques to regulate animal populations can be derived only after the animals and their habitats on the installation are well understood. Then, if ecologically feasible, the habitat elements may be manipulated so as to influence the animal populations as desired. The concept of wildlife management is well understood, but there are serious restrictions to putting it into practice. At an installation as large and diverse as Fort Carson, there are literally hundreds of animal species that are of importance to the ecosystem, yet only a relatively few of the species are sufficiently understood to permit the specification of habitat modification. Further, basic data development for a given species is time-consuming and costly. It is recognized, however, that an ecosystem that is ideal for one species will also be adequate for many others, thus offering the hope that overall habitat improvement can be effected by concentrating on the needs of a few major species. Further, the literature contains considerable data on selected wildlife species. After considering the above factors, the WES selected two

major points of departure for this study: first, identifying those species that were of direct interest to Fort Carson; and second, developing an effective means of extracting and assembling the literature data so as to be readily useable in management plan development.

Selection of Species

10. The Land Management Branch, DFAE, requested that a narrative account be prepared for all animals that are legally protected under Federal or state laws against harassment, harm, capture, killing, or habitat disturbance, and whose range approaches or includes Fort Carson. A review of existing Federal and state laws produced the following list:

Species	Federally Protected	State Protected
Mammals		
Black-footed ferret (*Mustela nigripes*)	X	X
River otter (*Lutra canadensis*)	--	X
Birds		
Mexican duck (*Anas diazi*)	X	X
American peregrine falcon (*Falco peregrinus anatum*)	X	X
Whooping crane (*Grus americana*)	X	X
Eskimo curlew (*Numenius borealis*)	X	X
Greater sandhill crane (*Grus canadensis tabida*)	--	X
White pelican (*Pelecanus erythrorhynchos*)	--	X
Greater prairie chicken (*Tympanuchus cupido*)	--	X
Lesser prairie chicken (*Tympanuchus pallidicinctus*)	--	X

11. Fort Carson also requested that narrative accounts be prepared on the following game and nongame species:

a. Mule deer (*Odocoileus hemionus*).

b. Pronghorn (*Antilocapra americana*).

c. Black-tailed prairie dog (*Cynomys ludovicianus*).

d. Scaled quail (*Callipepla squamata*).

e. Bobcat (*Felis rufus*).

f. Mountain lion (*Felis concolor*).

g. Coyote (*Canis latrans*).

h. Golden eagle (*Aquila chrysaetos*).

i. Mourning dove (*Zenaidura macroura*).

j. Cottontail rabbit (*Sylvilagus audubonii* and *S. nuttallii*).

k. Abert's squirrel (*Sciurus aberti*).

l. Black bear (*Ursus americanus*).

Developing Wildlife Data

12. The Land Management Branch, DFAE, after a review of a list of information categories presented in a recent WES report,[4] identified the following 14 information categories that were required for each species to meet Fort Carson's data needs:

a. Family.

b. Species.

c. Legal status.

d. Value potential, positive.

e. Value potential, negative.

f. Description.

g. Range.

h. Habitat.

i. Food habits.

j. Shelter requirements.

k. Nesting and bedding requirements.

l. Ritual requirements.

m. Population structure and trends.

n. Reproduction and survival.

o. Bibliography.

The definitions of these 14 information categories are presented in Appendix A. The species and data requirements were used to guide an extensive literature review. In addition, data from Fort Carson wildlife authorities, state fish and wildlife biologists, and Colorado State University wildlife experts were obtained. The data were analyzed, and a narrative account was prepared for each game and nongame species listed in paragraph 11 (Appendixes B-M). Narrative accounts on all the Federally and state protected species (except the river otter, white pelican, and greater sandhill crane) listed in paragraph 10 are not presented in this report but are available through a WES-developed on-line computer information system for environmentally sensitive wildlife.[4] The narrative accounts in the information system were prepared for all birds and mammals in the continental United States that were listed as "threatened wildlife" in the 1973 "Redbook,"[5] which did not include the river otter, white pelican, and greater sandhill crane. Information on these three species is available from the Division of Wildlife, Department of Natural Resources, Denver, Colorado. The narrative accounts in this system are updated at irregular time intervals. An updated narrative account (which is not presently available from the system) on the black-footed ferret was prepared in March 1977 and is presented in Appendix N.

13. At the time of this report, there have been no confirmed sightings of any of the 10 endangered mammal and bird species on Fort Carson. Several sightings of the black-footed ferret have been recorded in Colorado in the last 20 years; however, these sightings occurred on the eastern plains and in the extreme southeastern part of the state. A statewide campaign to eradicate prairie dogs--an integral part of the diet of the black-footed ferret--in favor of intensive agriculture and grazing has led to a substantial reduction in the population of the prairie dogs over much of Colorado. This reduction in the number of prairie dogs has probably contributed significantly to the near

extirpation of the black-footed ferret in Colorado and, therefore, on the Fort Carson reservation. However, as will be discussed in Part III, a considerable number of prairie dogs exist on the Fort Carson reservation.

PART III: IDENTIFICATION AND MAPPING OF WILDLIFE HABITATS

Background

14. Wildlife management as currently practiced in the United States primarily involves the modification of animal habitats. This element of the man-land-animal triad became important after the passage of state "bag limits" legislation in the 1920's. That legislation stabilized game animal populations by limiting the harvest of the populations. Deer, turkey, and rabbit populations rapidly reached the carrying capacities of their habitats, and little further increase in annual harvests occurred. Federal and state wildlife management personnel began seeking ways to improve or increase the size or number of suitable habitats in an area and thus increase the carrying capacity of that area for game animal populations. The need for detailed objective procedures for evaluating environments as to their suitability to sustain certain animal populations was soon recognized. Several subjective evaluation procedures were developed[3] and continue to be developed.[6]

15. The Land Management Branch, DFAE, has used habitat improvement to increase animal populations at Fort Carson. For example, additional water sources were developed, and several forage plant species were planted in selected areas on the reservation to enhance those areas for wildlife (Appendix O). Although these efforts provided a measure of general improvement, habitat enhancement for a particular species requires more species-specific information on habitat requirements than was then available.

16. Determining the actual habitats of most animals is difficult because the habitats are very localized. That is, the actual occurrence of an animal within the region defined as its range is usually very limited. Within the general range, each animal tends to occupy a specific and areally limited environment; these are, in effect, microenvironments. For example, the beaver (Castor canadensis) has a range covering virtually all of North America except the extreme Arctic; thus,

for example, the Turkey Creek drainage basin at Fort Carson is well within its range. However, this does not mean that the beaver will actually be present on every square kilometre of the Turkey Creek drainage basin. In fact, the only place within the Turkey Creek drainage basin where one has been found is just below the dam at Teller Reservoir. The beaver is largely aquatic, and its primary diet consists of bark and cambium of willows, alders, birches, and aspens. However, it is not totally aquatic; it requires a streambank in which to build maternity dens. Thus, its habitat (i.e. the microenvironment in which it actually lives) is a narrow zone along lakeshores and streambanks. This zone may actually be only a few metres wide. For all practical purposes, the broad upland areas away from streams and lakes are devoid of beavers because they are not "habitats."

Procedural Steps for Habitat Identification and Mapping

17. The previous discussion illustrates several reasons for the difficulties encountered in delineating wildlife habitats in the field. Even so, there emerges from the study a concept consisting of five procedural steps that, if carefully implemented, will result in a useful habitat mapping capability. The five procedural steps for habitat identification and mapping are as follows:

a. Identify the habitat requirements of the species. Habitat requirements are those minimal environmental factors that a species requires to survive and reproduce viable offspring.

b. Locate the required factors in the geographic area of interest. The use of remote sensing techniques by the WES,[7] augmented by ground truth, were used to map these factors.

c. Prepare map overlays showing the extent of each factor in the geographic area. (This procedure is described in Reference 8.)

d. Prepare composite map. Those geographic areas where all critical factors occur are "potential habitats" for the species. Potential habitats are those areas that contain all the minimal habitat requirements of a species.

e. Verify map.

18. The critical step in this procedure is to identify the habitat requirements of the species. The narrative account, if sufficiently complete for the species, provides the data for specifying species' habitat requirements. Once the factors are known, they can be mapped using ground truth and air-photo interpretation techniques. Some factors, such as linear hedge row and soil types, can be readily interpreted from air photos. Other factors, such as water quality and herbaceous vegetation species, will require considerably more ground truth data. Map preparation and compilation (i.e. stacking) can be accomplished by several procedures. The procedures used in this study were fashioned after those developed previously at the WES and documented in Reference 8. Verification must be done by field observations. Details of the procedural steps and their adequacy to delineate habitats can best be illustrated by way of example, as discussed in the following paragraphs.

Application of the Habitat Identification and Mapping Procedures

19. In order to test and demonstrate the habitat mapping procedures, two species with highly divergent habitat requirements were selected for detailed study on Fort Carson: the black-tailed prairie dog and the mule deer. The black-tailed prairie dog is an example of a social species that can become an undesirable pest. The mule deer is an example of a solitary, widely hunted game species and, therefore, is a highly valuable species from a recreational and aesthetic standpoint.

20. The tests for both species were designed to test the hypothesis that the habitats in which the two species currently exist would be identified as "potential habitat" using the habitat identification and mapping procedures. The tests of this hypothesis are described below.

Potential black-tailed prairie dog habitats

21. Identification of habitat requirements. Several authors have indicated that certain selected environmental factors of the black-tailed

prairie dog's habitat appear to limit the actual occurrence of the species within its range (see description of "Habitat" in Appendix D). According to this literature, the important factors for the black-tailed prairie dog are topographic elevation and slope, vegetation species, plant height, percent ground cover, and soil type. These factors within the Colorado habitat areas are reported as:

- a. Elevation: less than 2800 m.*
- b. Slope: 0-10 deg.
- c. Vegetation type: short- and mixed-grass prairie species.
- d. Vegetation height: less than 30 cm.
- e. Vegetation cover: 5-50 percent.
- f. Soil type: deep cohesive soils (loam, silty loam, clay, clay loam, and sandy loam).

22. Since all the values for the four environmental factors (elevation, slope, vegetation, and soil) were obtained from literature that reports the results of black-tailed prairie dog studies performed outside of Fort Carson (Appendix D), the WES conducted a short field sampling program of seven prairie dog towns on Fort Carson to determine if the literature-reported values for the four factors were applicable to Fort Carson. In addition, data were collected on physical characteristics of the prairie dog burrows (mound height, mound diameter, burrow-opening diameter, tunnel azimuth, tunnel slope, and mean area per burrow), terrain downslope azimuth, and soil moisture. Although not previously reported as significant in the literature, these additional environmental factors were considered as possibly limiting the occurrence of the prairie dog. The sampling program (Appendix P) indicated that the values for elevation, slope, vegetation, and soil in the seven prairie dog towns were within the range of values for those factors (see paragraph 21) reported in the literature. The other environmental factors considered in the sampling program were not used

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* A table of factors for converting metric (SI) units of measurement to U. S. customary units and U. S. customary units to metric (SI) units is given on page 6.

for mapping because they could not be identified as limiting the occurrence of the prairie dog on the basis of the limited field data.

23. Locating and mapping the environmental factors. With the above habitat requirements in mind, the next problem was the determination of where these factors occur on Fort Carson. Thus, it was first necessary to map the environmental factors for the complete reservation at a sufficient level of detail to permit a reliable assessment of potential habitat areas. The data on vegetation, soils, and slope were mapped at a scale of 1:50,000 for the reservation. Elevation was not used as a factor for mapping potential habitat areas since all ground elevations at Fort Carson (1628-2102 m) are less than the 2800-m maximum elevation for prairie dog habitats reported in the literature. The following tabulation presents the factor classes and factor class ranges that were established for the mapping:

Environmental Factor	Factor Class	Factor Class Range
Slope	1	0-5 deg
	2	5-10 deg
	3	>10 deg
Soil	1	Loam and silty loam†
	2	Clay and clay loam†
	3	Sandy loam†
	4	Other††
Vegetation	1	Short- and mixed-grass prairie species
	2	Forest

† Depths $\geq$ 30 in.
†† Exposed rocks, cobbles, gravels, sands, silts, loams, and clays < 30 in. in depth.

The methods used to map the environmental factors are discussed below.

24. The slope data were obtained manually* with a clear acetate template (Figure 1) and the 1:50,000 scale topographic map of the

* Although a manual procedure was used for determining slope for the Fort Carson Reservation, the WES has developed an automated procedure for calculating slope direction and magnitude and for constructing slope maps. This automated procedure is discussed in detail in Reference 9.

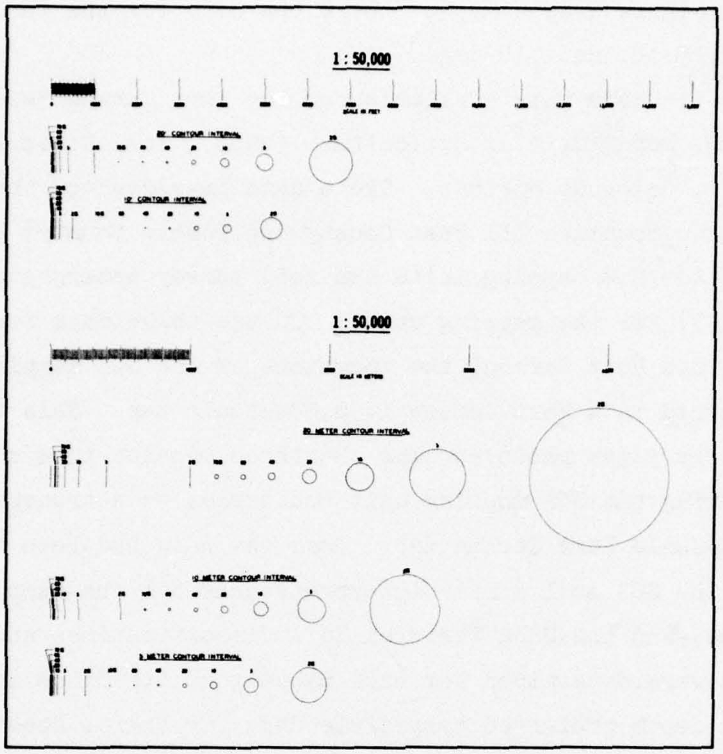


Figure 1. Template used for mapping slope at Fort Carson

reservation. The procedure consisted of selecting the map scale (1:50,000) and contour interval (20 ft) on the template that coincided with that of the Fort Carson map. The template was transparent so that contour lines could be readily seen through them. This was necessary since the technique of ascertaining slope classes at every location required overlaying the template on the map and moving it freely over the contour lines. The slope classes were determined by finding the set of slope class circles that bracketed the separation between two contour lines. For example, if at a given location on the topographic map, the distance between a pair of contour lines was greater than the inner circle of a given slope class range but less than the outer circle for that range, the map location was classed as that slope class range and marked accordingly. This process was repeated many times over the entire topographic map until the slope conditions had all been

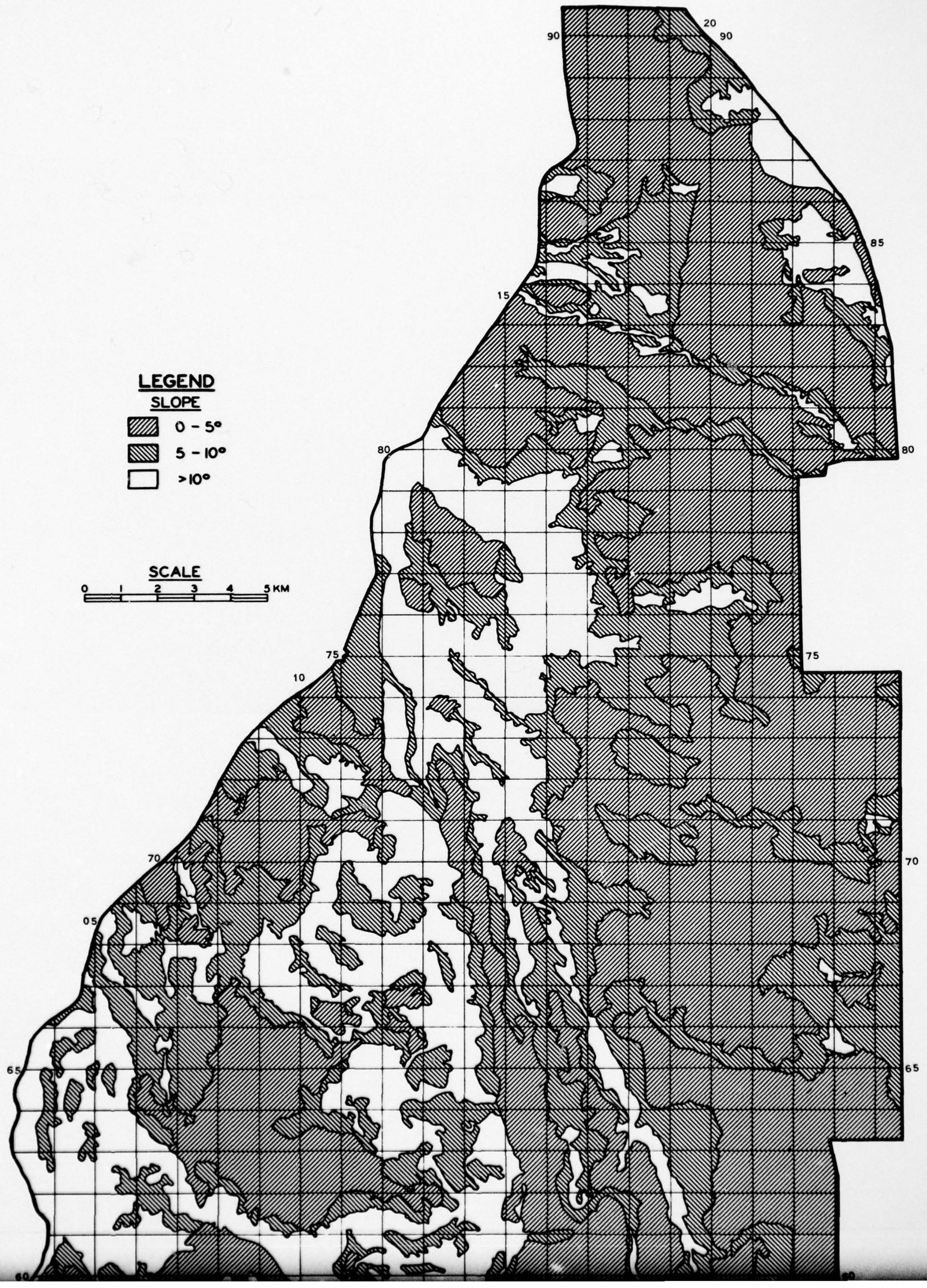
determined. Figure 2 is a map of the slope data for the three factor classes (0-5, 5-10, and >10 deg).

25. Soils data were available for the Fort Carson Reservation from the U. S. Department of Agriculture (USDA), Soil Conservation Service (SCS), Colorado Springs. These data consisted of three photomosaics for two counties (El Paso County and Pueblo County) showing the locations of the SCS mapping units and soil survey interpretations (SCS Forms 5-5) for the mapping units. To use these data for assessing the soils within Fort Carson, the locations of the SCS mapping units were transferred to a Fort Carson 1:50,000-scale map. This transfer was accomplished by first photoreducing the three mosaics to a common scale and transferring the SCS mapping unit boundaries to a transparency of the 1:50,000-scale Fort Carson map. Once the data had been transferred to the map, the SCS soil survey interpretations for the mapping units were reviewed, and the USDA Textural Soil Classifications and the depths of the soils were determined for each mapping unit. Since data on the minimum soil depth preferred by prairie dogs for burrow construction was not available from the literature (Appendix D), the minimum soil depth in the seven WES-surveyed prairie dog towns (Appendix Q) was determined to be 30 in. from the SCS soils data. Using the USDA Textural Soil Classifications and the requirement for a minimum soil depth of 30 in., four factor classes were established: loam and silty loam, clay and clay loam, sandy loam (all $\geq$ 30 in. in depth), and other (exposed rocks, cobbles, gravels, sands, silts, loams, and clays < 30 in. in depth). Figure 3 presents a 1:50,000-scale Fort Carson soil map based on these factor classes.

26. The vegetation map (Figure 4) depicts the data for the two factor classes, short- and mixed-grass prairie species and forest, as interpreted from 1:20,000-scale black-and-white photography flown in 1974.

27. Identification of potential habitat. After the three environmental factors (slope, soil, and vegetation) had been mapped at 1:50,000 scale, they were combined into a landscape complex map by superimposing each of the individual maps on a common base map

1



LEGEND
SLOPE
0 - 5°
5 - 10°
>10°
SCALE
0 1 2 3 4 5 KM
90
20
90
85
15
80
80
75
75
10
70
70
05
65
65

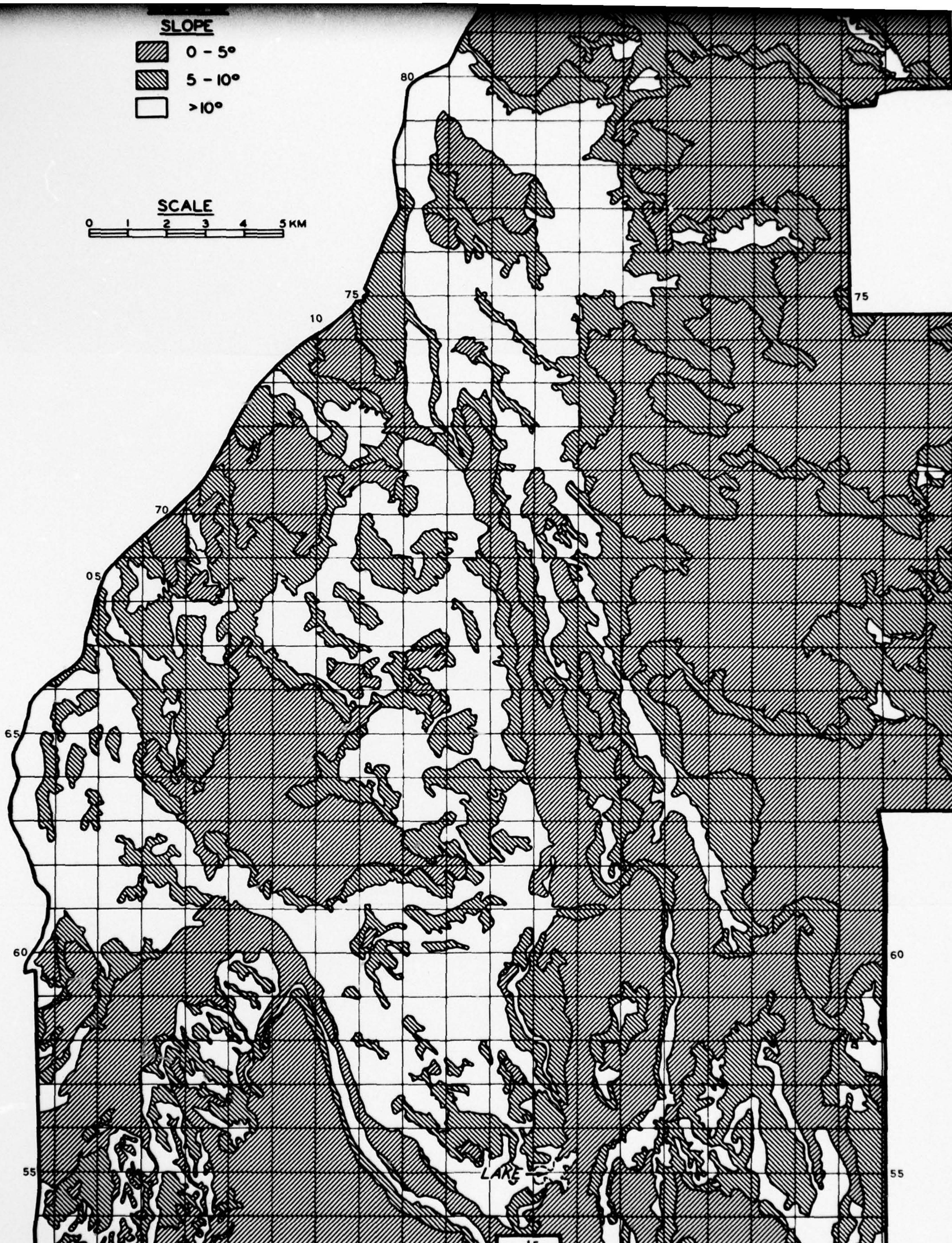
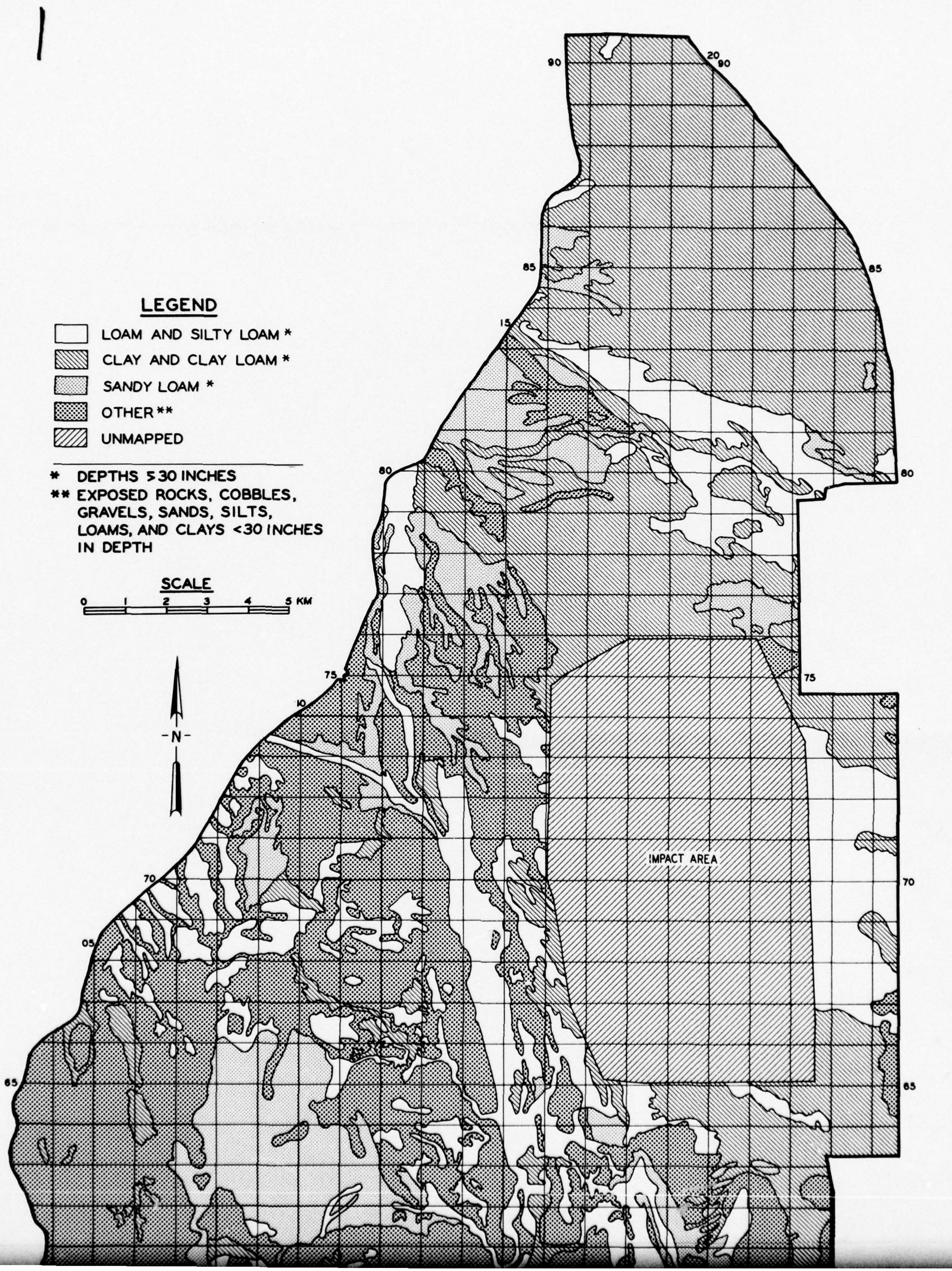


Figure 2. Slope map of the Fort Carson Reservation

2



1
LEGEND
LOAM AND SILTY LOAM *
CLAY AND CLAY LOAM *
SANDY LOAM *
OTHER **
UNMAPPED
* DEPTHS ≥30 INCHES
** EXPOSED ROCKS, COBBLES, GRAVELS, SANDS, SILTS, LOAMS, AND CLAYS <30 INCHES IN DEPTH
SCALE
0 1 2 3 4 5 KM
-N-
IMPACT AREA
90
20
90
85
85
15
80
80
75
75
10
70
70
05
65
65

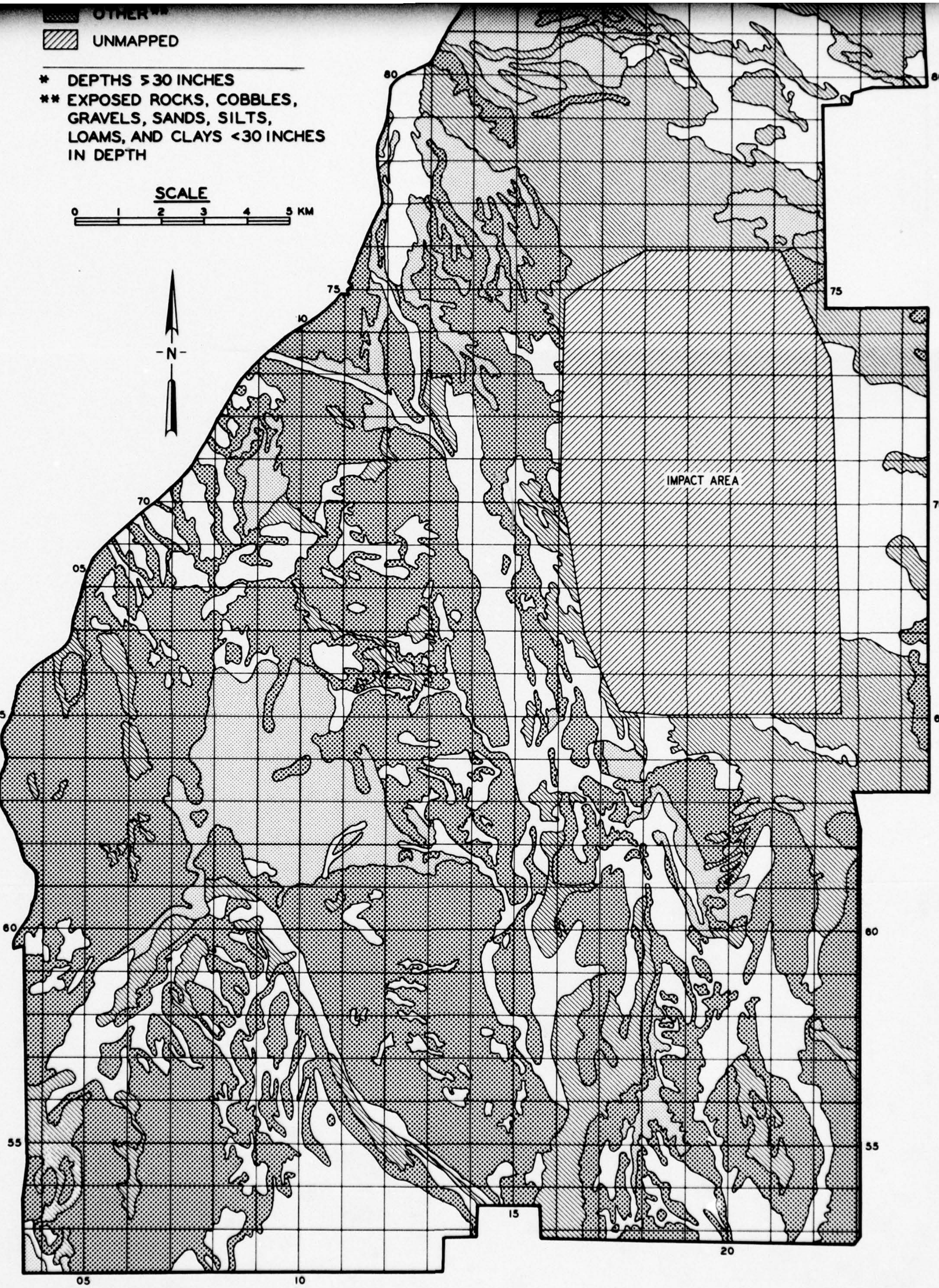
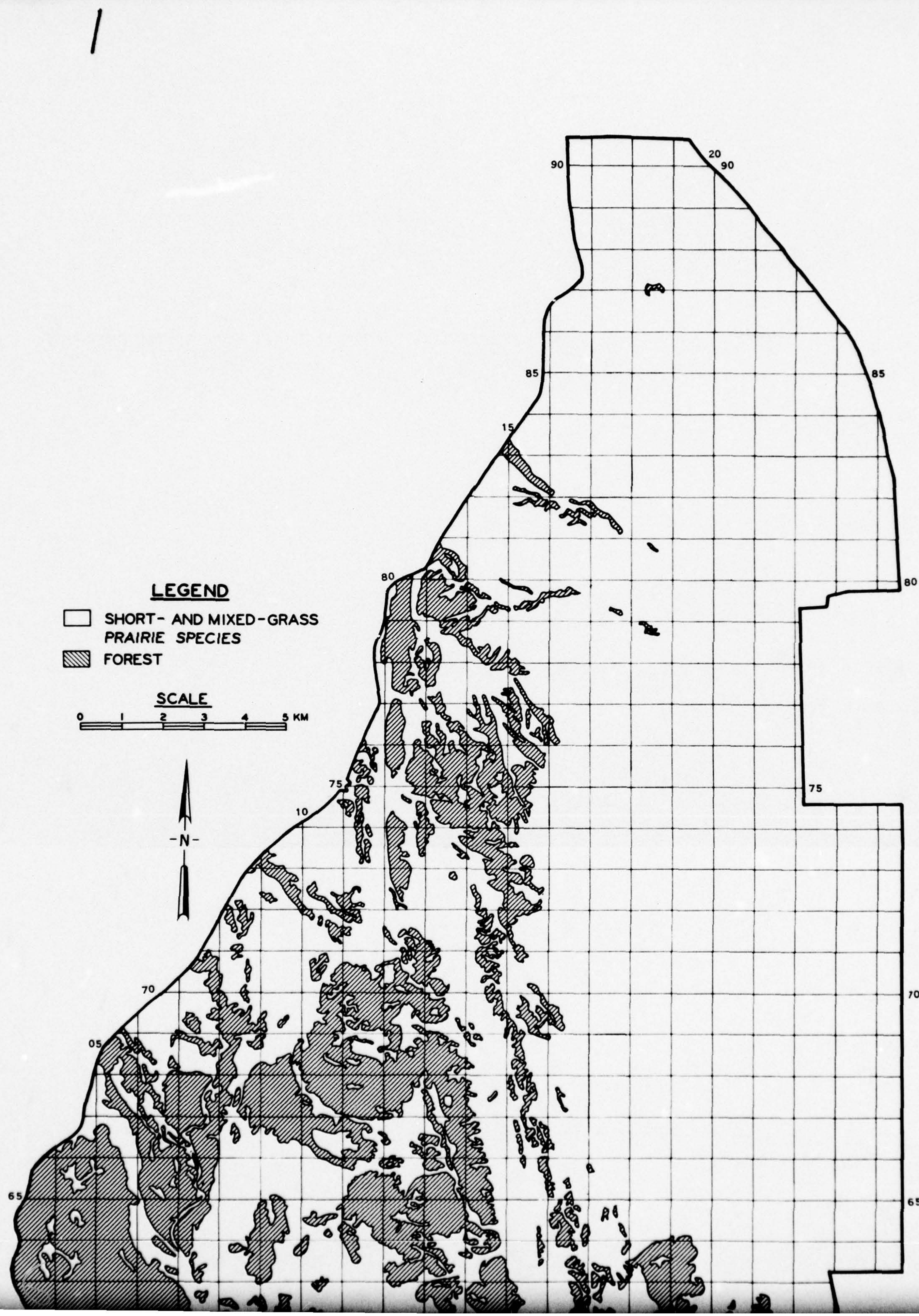


Figure 3. Soils map of the Fort Carson Reservation

2


1
LEGEND
SHORT- AND MIXED-GRASS PRAIRIE SPECIES
FOREST
SCALE
0 1 2 3 4 5 KM
N
90
20
90
85
85
15
80
80
75
75
10
70
70
05
65
65

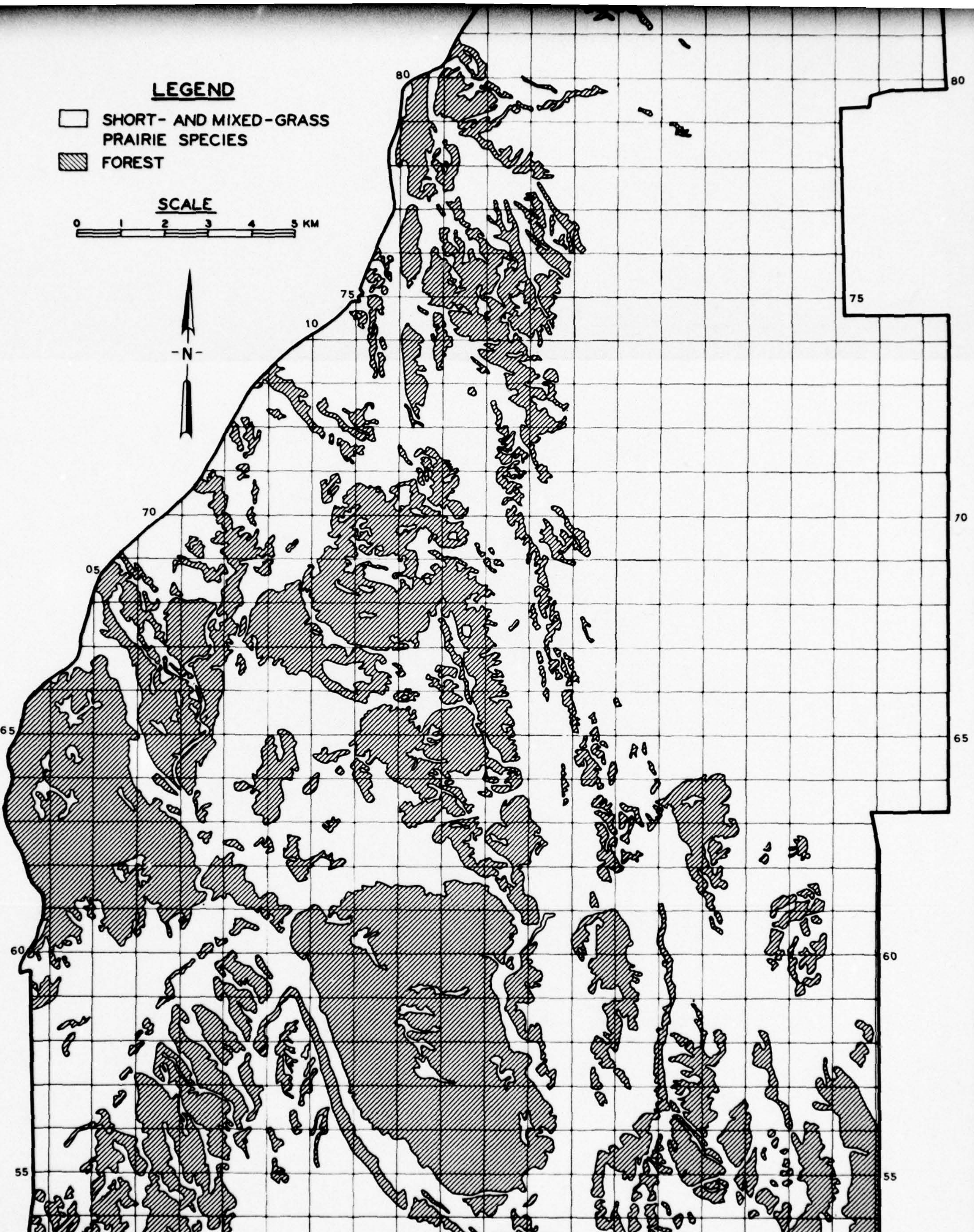


Figure 4. Vegetation map of the Fort Carson Reservation

2

(Figure 5). The terrain patches on the landscape map that contained slope classes 1 or 2, vegetation class 1, and soil classes 1, 2, and 3

NOTE: THE INDIVIDUAL TERRAIN FACTOR MAPS ARE DRAWN ON TRANSPARENT DRAFTING FILM SO THAT THEY CAN BE STACKED. CODES ON INDIVIDUAL TERRAIN FACTOR MAPS ARE FOR THE FACTOR CLASSES DESCRIBED IN PARAGRAPH 23. IN THIS EXAMPLE, PATCHES 2, 2, 1; 2, 3, 1; AND 2, 1, 1 ON THE COMPOSITE MAP ARE POTENTIAL HABITAT AREAS (PARAGRAPH 27).

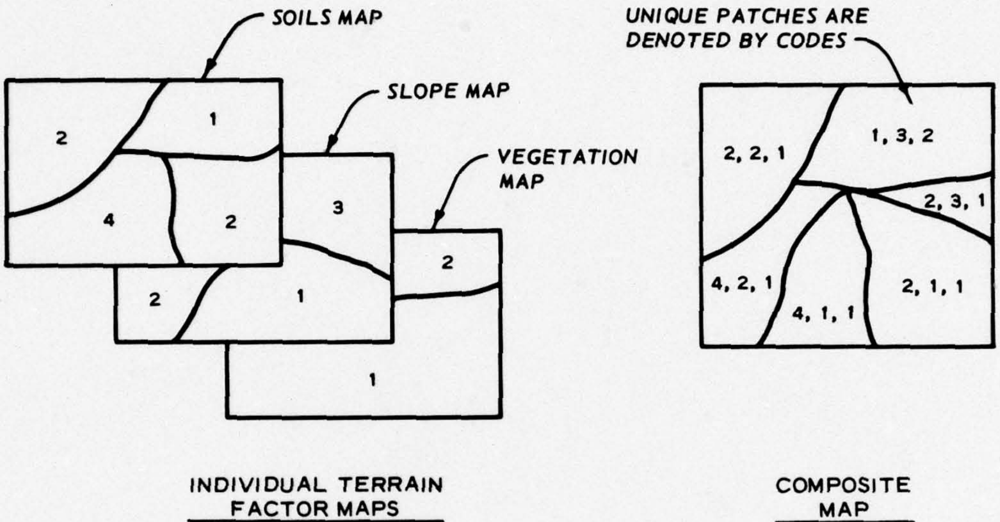
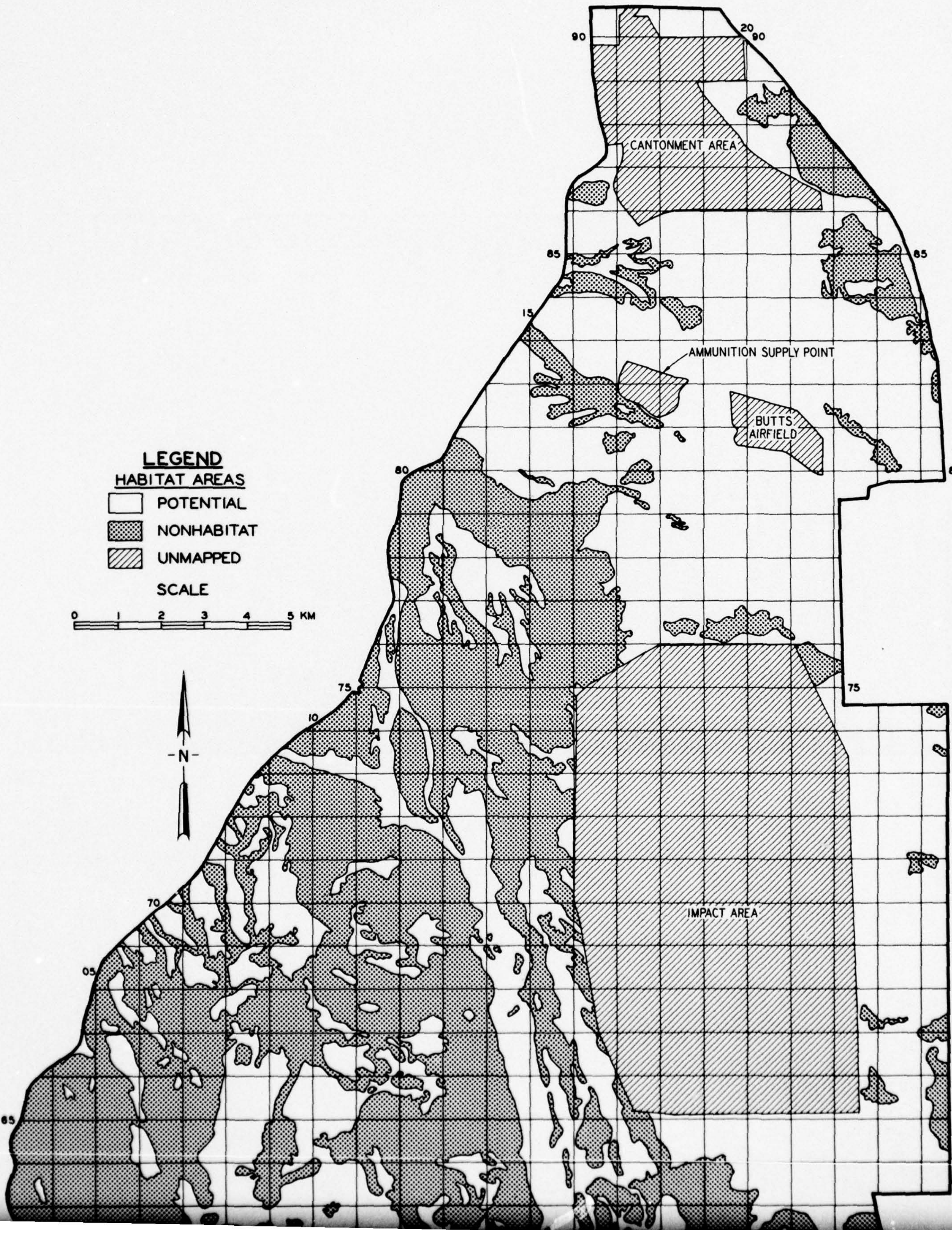


Figure 5. Compilation of individual terrain factor maps to form composite map

were considered to be "potential" habitat areas for the black-tailed prairie dog. This landscape map was then used to produce a final potential habitat map (Figure 6) of the Fort Carson Reservation. The total area of the potential habitats is 70,000 acres (52 percent) of Fort Carson. The unmapped areas on this potential habitat map include the cantonment area, the ammunition supply point, Butts airfield, and the main impact area. Of these, only the main impact area may have additional potential habitat areas for the prairie dog; however, the intensive use of that area for artillery, mortar, tank, and rocket fire would probably discourage the establishment of prairie dog towns.

28. Verification of potential habitat map. Since the prairie



90
20
90
CANTONMENT AREA
85
85
15
AMMUNITION SUPPLY POINT
BUTTS
AIRFIELD
LEGEND
HABITAT AREAS
POTENTIAL
NONHABITAT
UNMAPPED
SCALE
0 1 2 3 4 5 KM
80
80
75
75
10
-N-
70
70
IMPACT AREA
05
65
65

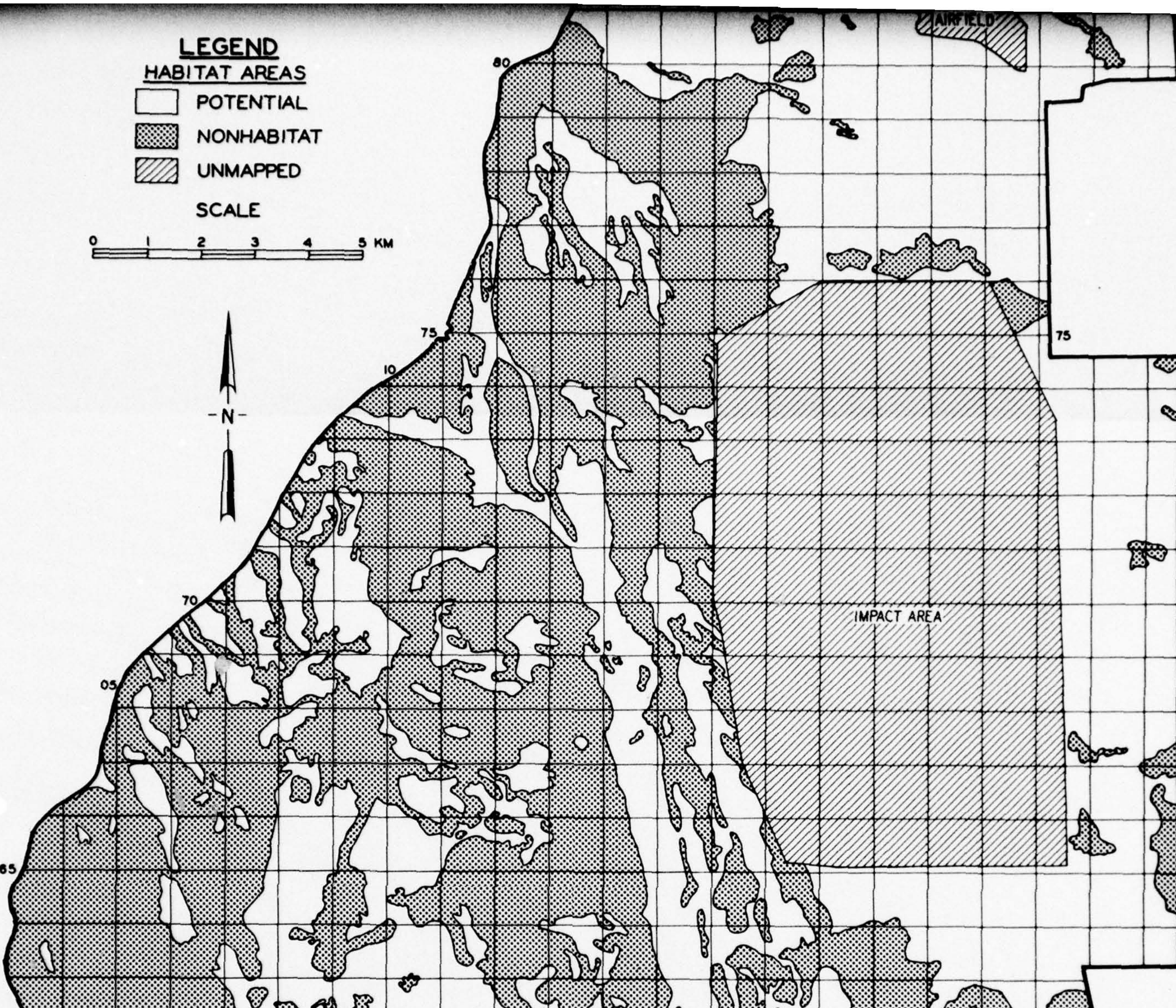


Figure 6. Map of potential habitat areas for the black-tailed prairie dog

2

dogs are social animals that live in colonies (prairie dog towns), the existing prairie dog habitats on Fort Carson were those areas where prairie dog towns occurred. Therefore, the procedure used in the verification was to locate and map the locations of the existing prairie dog towns and compare their locations to the areas identified as potential habitats. If the habitats (town locations) were correctly located in the mapped "potential habitat" areas, this would tend to support the hypothesis that the application of the five procedural steps (see paragraph 17) resulted in a realistic map of the prairie dog's "potential habitat."

29. Locating and mapping of prairie dog towns. The locations and sizes of prairie dog towns were determined by air-photo interpretation techniques and ground reconnaissance. Aerial photography of the Fort Carson Reservation at several different scales was available for use as follows:

Type of Imagery	Scale	Date Flown
Black-and-white	1:20,000	August 1962
Black-and-white	1:80,000	June 1972
Black-and-white	1:20,000	September 1974
Black-and-white	1:20,000	August 1974 (partial coverage)
Color-infrared	1:5,000	August 1974 (partial coverage)
Color	1:5,000	August 1974 (partial coverage)
Black-and-white	1:20,000	August 1975

30. The interpretation of the locations of the prairie dog towns consisted of a stereoscopic examination of overlapping prints, whereby the various photographic terrain patterns of the prairie dog towns were identified according to their tone, texture, and topographic settings. The small (≈2- to 3-m-diam) circular soil mounds of the prairie dogs could be readily identified on the 1:5,000 and 1:20,000 photography but not very easily on the 1:80,000. The polka-dot type pattern of the burrows within the towns (Figure 7) was the key to identifying the towns. In some regions of the reservation, it was difficult to distinguish the prairie dog burrows from the mounds that had been

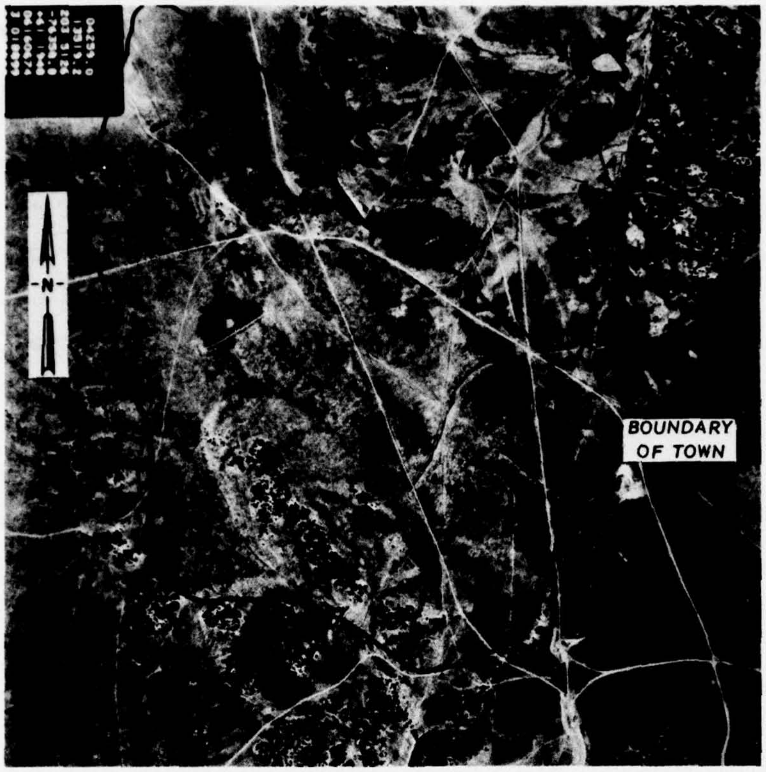


Figure 7. Air photo (1:20,000 scale) showing a large prairie dog town, Fort Carson, Colorado

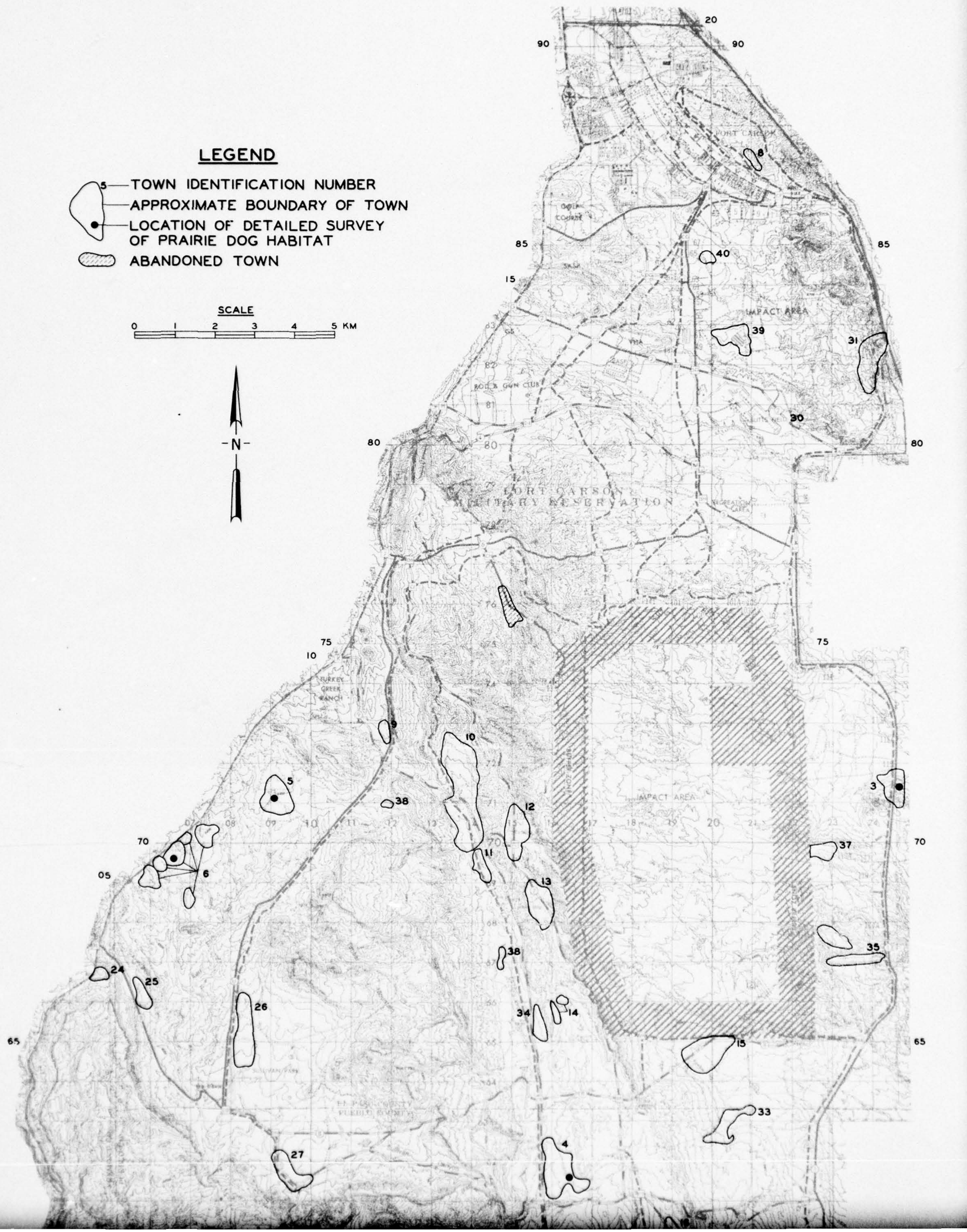
constructed by harvester ants (Pogonomyrmox sp.) (Figure 8). Therefore, all the towns located on the aerial photography were field checked as described below.

31. After all the prairie dog towns had been outlined on the air photos, their boundaries were field checked by ground reconnaissance, which revealed that some of the towns had expanded since the air photos had been flown. The field reconnaissance also showed that three of the photo-interpreted towns contained no live animals. The final boundaries of the prairie dog towns, as determined from the air photos and as field checked by ground surveys, were transferred to a 1:50,000-scale topographic map of the Fort Carson Reservation. This map (Figure 9) depicts 40 existing towns (containing live black-tailed prairie dogs) and three towns that were abandoned (i.e. contained no live prairie dogs). The amount of land occupied by the 40 active black-tailed prairie dog towns

a. Mound of harvester ants

b. Burrow of black-tailed prairie dog

Figure 8. Ground photographs showing earth mounds constructed by harvester ants and by a black-tailed prairie dog



LEGEND
TOWN IDENTIFICATION NUMBER
APPROXIMATE BOUNDARY OF TOWN
LOCATION OF DETAILED SURVEY OF PRAIRIE DOG HABITAT
ABANDONED TOWN
SCALE
0 1 2 3 4 5 KM
N
FORT CARSON
FORT CARSON MILITARY RESERVATION
IMPACT AREA
ROD & GUN CLUB
TURKEY CREEK RANCH
EL PASO COUNTY
PUEBLO COUNTY

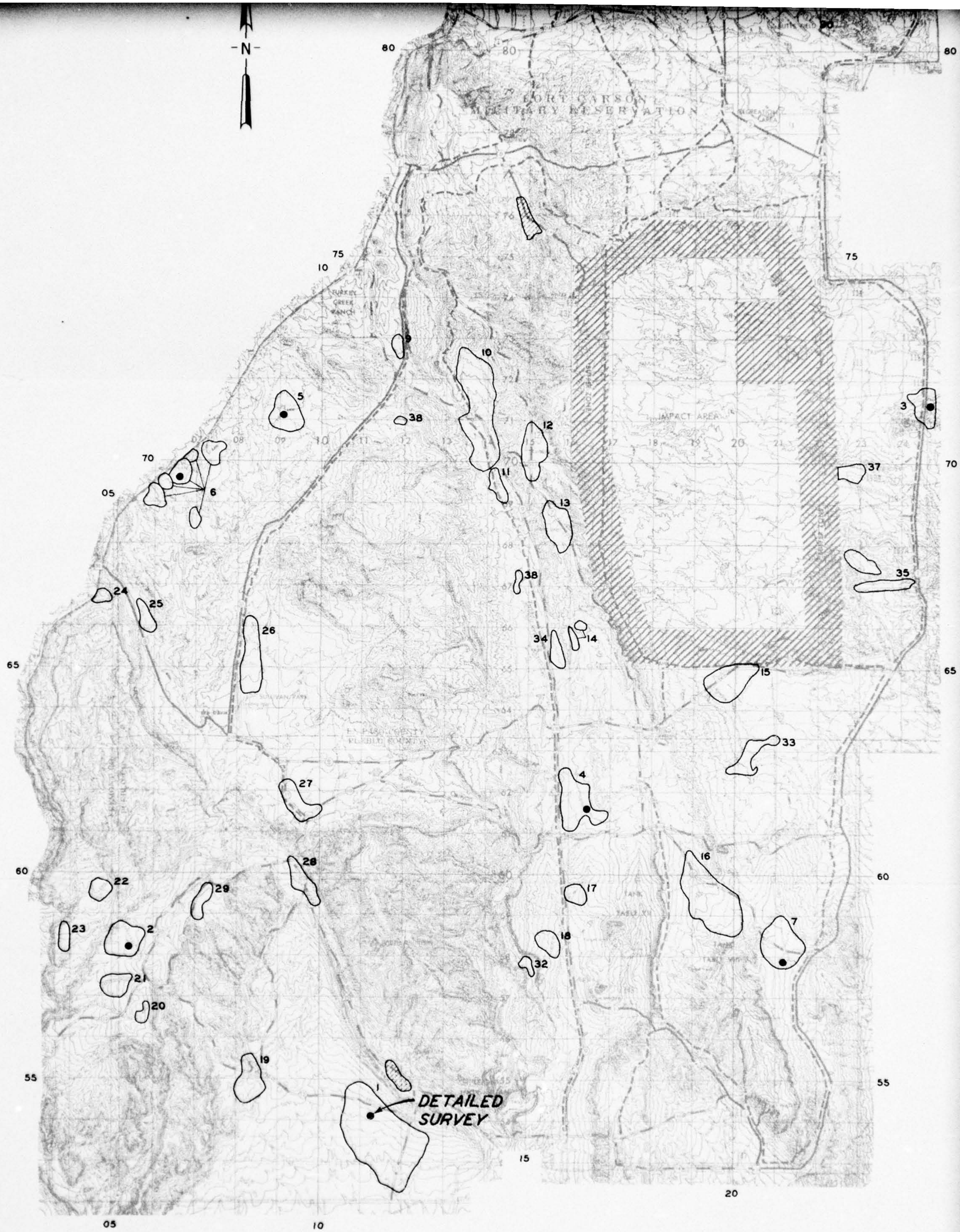


Figure 9. Map of existing and abandoned prairie dog towns on the Fort Carson Reservation (June 1976)

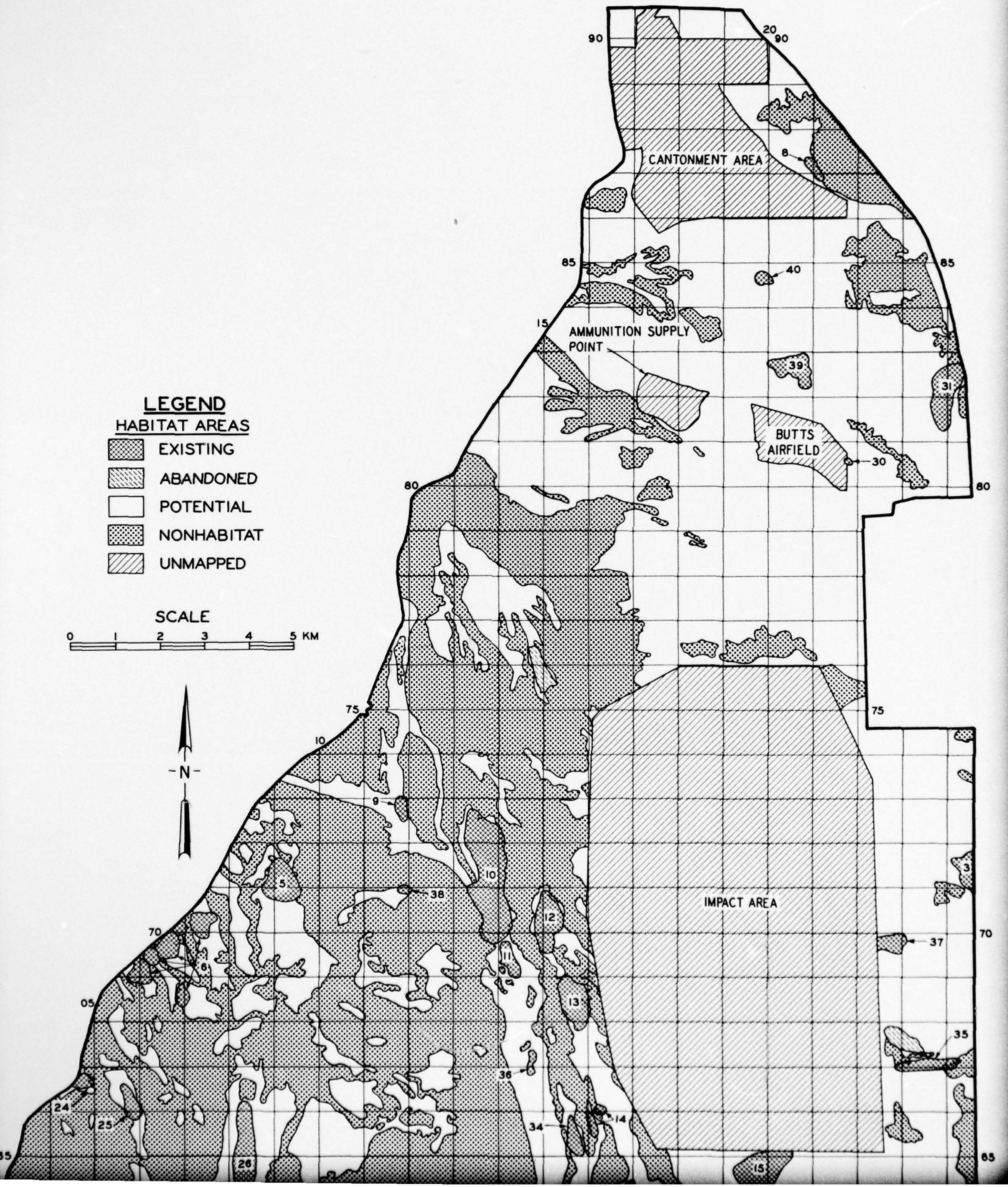
2

on the Fort Carson Reservation was calculated to be approximately 5000 acres, i.e., about 7 percent of the potential habitat areas were occupied.

32. The locations of the existing and abandoned towns were compared to the locations of the areas identified as potential habitats (Figure 10). If 95 percent or more of each town area was located within an area identified as potential habitat, the town was considered to be within the potential habitat. Of the 40 existing and 3 abandoned towns, 37 existing towns and all 3 abandoned towns (93 percent) were found to be located within the areas identified as potential habitat for the prairie dog. Although this accuracy is considered adequate for delineation of potential habitat areas for wildlife management purposes, the WES desired to determine why from 18 to 50 percent of the area of three of the existing towns (16, 19, and 23) were located in areas that were not identified as potential habitat.

33. Sources of error. An evaluation of the procedural steps used to map the potential habitat areas indicated that there were three possible sources of error in using those procedures. First, the factor class ranges established for the environmental factors (see paragraph 23) might not represent the range of values for those factors on Fort Carson, despite the results of the short field sampling program (see paragraph 22). Second, the mapping of the factors used to delineate the potential habitat areas may in some instances be in error. Third, other environmental factors influencing the selection of prairie dog habitat may have been overlooked in the previous studies of the prairie dog (i.e. not reported in the literature). To determine which of the three possible sources of error individually or collectively contributed to the inaccuracy in the identification of potential prairie dog habitats the WES: (a) analyzed the active prairie dog towns to determine the values for the environmental factors in the towns, (b) compared the interpreted values for the environmental factors in the towns to the measured values for those factors, and (c) evaluated the adequacy of the literature-reported environmental factors to identify potential habitats of the prairie dog. The methods used in these analyses and evaluations

1



LEGEND
HABITAT AREAS
EXISTING
ABANDONED
POTENTIAL
NONHABITAT
UNMAPPED
SCALE
0 1 2 3 4 5 KM
N
CANTONMENT AREA
AMMUNITION SUPPLY POINT
BUTTS AIRFIELD
IMPACT AREA
90
20
90
85
85
15
80
80
75
10
75
70
70
05
65
65
8
40
39
31
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9
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5
38
12
11
6
13
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35
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24
25
34
14
26
15
3

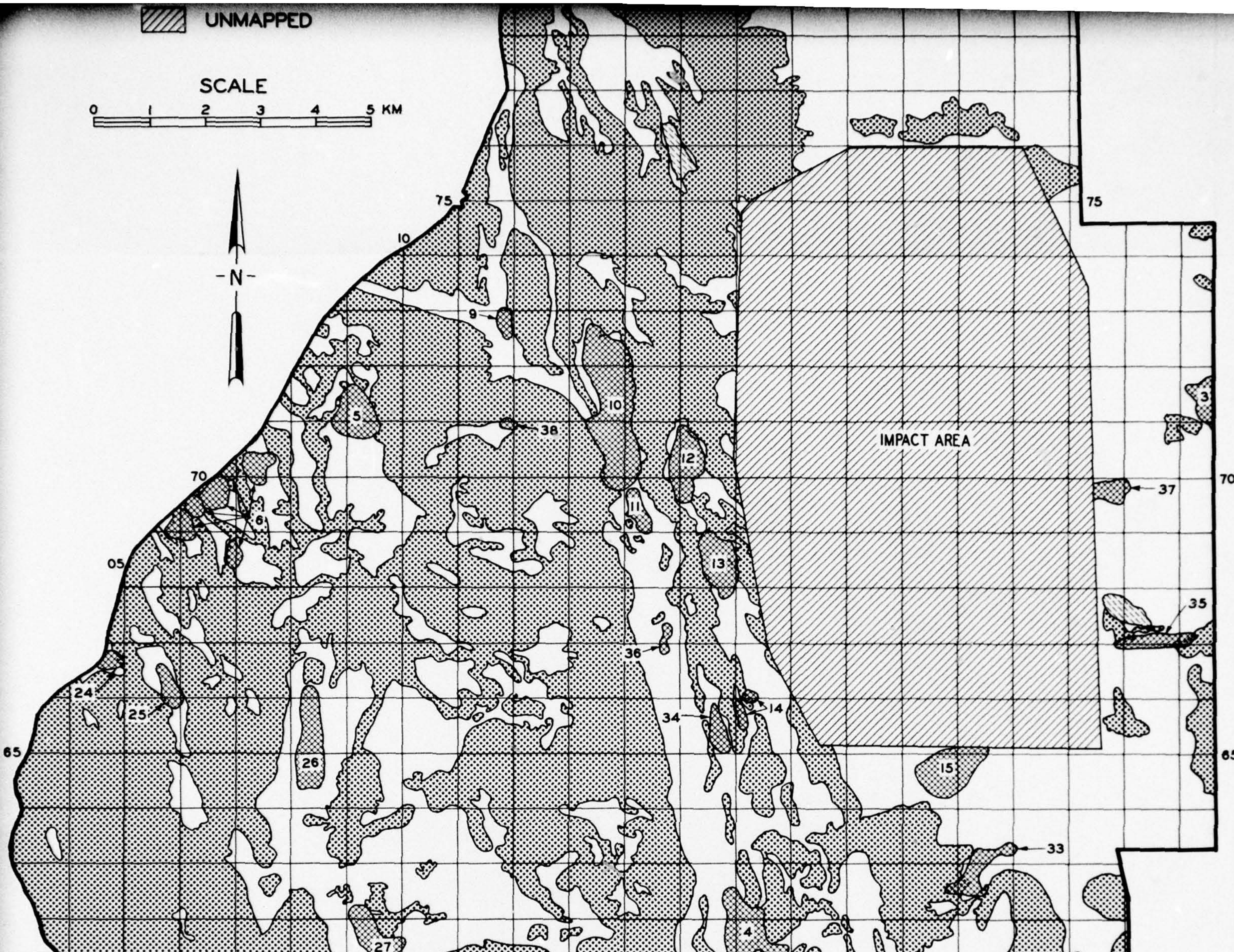


Figure 10. Map of existing and abandoned towns superimposed on potential habitat areas for the black-tailed prairie dog

2

are discussed in the following paragraphs.

34. Analysis of mapped prairie dog towns. The 40 active prairie dog towns, as depicted on the map in Figure 9, were analyzed to determine the values for the environmental factors in the towns. Topographic data pertaining to relief, elevation, downslope azimuth, and ground surface slope were determined from U. S. Geological Survey (USGS) 1:50,000 topographic maps of the reservation (Table 1).

35. Topographic relief (the difference in elevation between the high and low points of a land surface) was determined by locating the highest and lowest elevation values in the individual towns and subtracting the lowest from the highest value. Average elevation for each town was calculated by adding the highest elevation value to the lowest elevation value and dividing the result by two. Average downslope azimuth, slope range, and weighted mean slope for each town were computed in the following manner.

36. The contour lines within each town were carefully studied to determine where transect lines could be located that would be approximately perpendicular to intersecting contour lines (i.e., lines wherein the terrain slopes were along one specified direction). These lines were then drawn on the topographic map (Figure 11) from one edge of the town's boundary to the other. The downslope azimuth of each transect line was determined, and the average of these values was reported as average downslope azimuth. The transect lines were also used to determine the weighted mean slopes of the towns. Along each line, the lengths of the line segments between adjacent contour lines were measured. These measurements were used in the following equation to determine the terrain slope of the individual line segments:

$$S_i = \tan^{-1}\left(\frac{\overline{CI}}{4166.67L_i}\right) \tag{1}$$

where

S_i = slope of individual line segment, deg

$\overline{CI}$ = contour interval, ft

L_i = measured length of individual line segment, in.

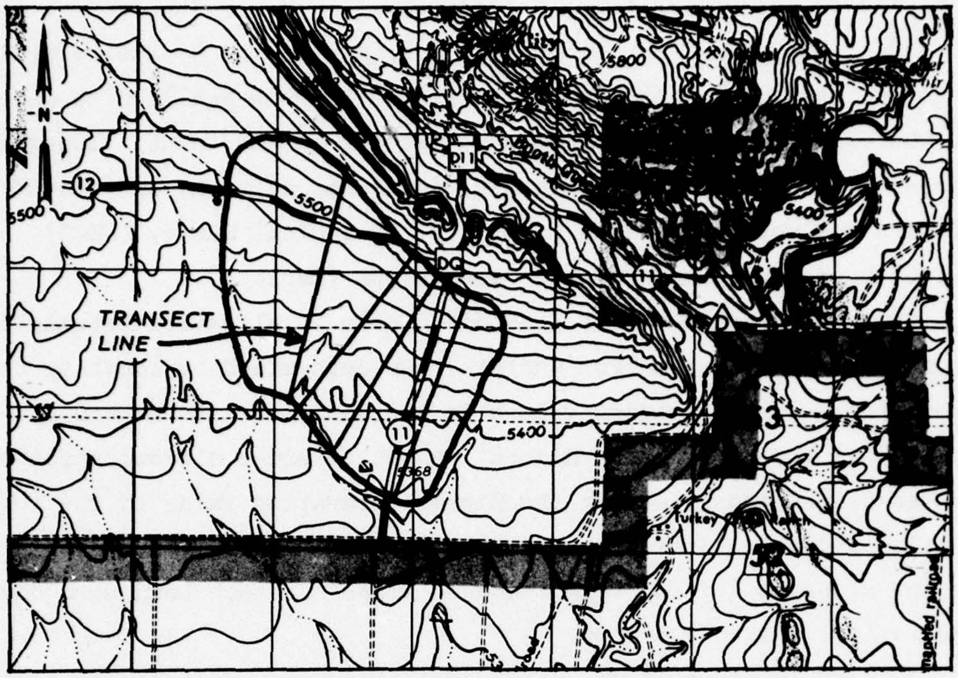


Figure 11. Location of transect lines within prairie dog town 1 (Figure 9) used to determine terrain slope of the town (*1:50,000-scale map*)

The resulting maximum and minimum values for each town are reported as slope range in Table 1. To compute a "slope value" that would be representative of the whole area occupied by the prairie dog town, a weighted mean slope for each town was calculated by the following equation:

$$\overline{S} = \frac{\sum_{i=1}^{N} S_i L_i}{\sum_{i=1}^{N} L_i} \qquad (2)$$

where

$\overline{S}$ = weighted mean slope for the town, deg

N = total number of measured line segments in the town

S_i = computed slope of individual line segment as given by Equation 1, deg

L_i = length of individual line segment

37. The data (Table 1) resulting from the topographic analysis of the 40 towns is summarized below. Relief varied from 1 m (town 40) to 73 m (town 10) with 90 percent of the towns (36 of 40) having reliefs in the 0- to 40-m range (Figure 12a). Average elevation in the 40 towns

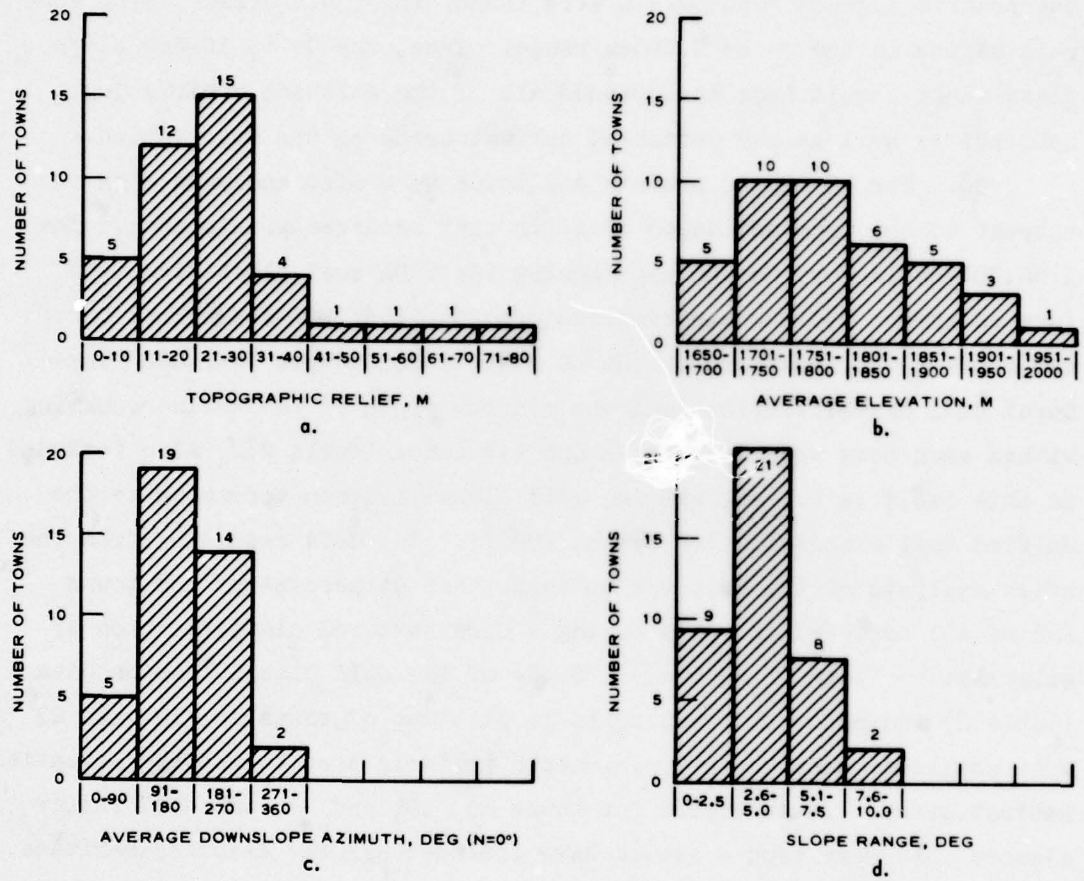


Figure 12. Class ranges of topographic factors within the prairie dog towns, Fort Carson, Colorado

varied from 1658 m (town 1) to 1951 m (town 5) with 90 percent of the towns (36 of 40) having average elevations in the 1650- to 1900-m range (Figure 12b). Average downslope azimuth varied from 55 deg (town 32) to 290 deg (town 36) with 82 percent of the towns (33 of 40) having average downslope azimuths in the 91- to 270-deg range (Figure 12c). The minimum slope occurring in a portion of any town was 0.4 deg (town 7), and the maximum slope in a portion of any town was 9.5 deg (town 35) with

100 percent of the towns (40 of 40) having slopes in the 0- to 10-deg range (Figure 12d). The minimum weighted mean slope was determined to be 0.8 deg (towns 27 and 37), and the maximum weighted mean slope was 3.7 deg (town 8). The slope data (Figure 12d) show that 100 percent of the prairie dogs at Fort Carson were inhabiting those areas having terrain slopes in the 0- to 9.5-deg range. Thus, the 0- to 10-deg slope class range should have encompassed all of the existing prairie dog habitats as well as any potential habitat areas on the reservation.

38. The 40 mapped prairie dog towns were also analyzed with respect to the type and depth of soils that occurred within them. The 1:50,000-scale Fort Carson map showing the USDA soil classifications (see paragraph 25) was superimposed onto the 1:50,000-scale Fort Carson map showing the locations of the 40 prairie dog towns. The USDA Textural Soil Classifications and the minimum depth of the soils occurring within each town were identified and tabulated (Table 2). Also included in this table is the engineering soil classification according to the Unified Soil Classification System (USCS). The data resulting from the soils analysis of the 40 towns indicate that 65 percent of the towns (26 of 40) occurred in soils having a USDA textural classification of silty loam or loam (Figure 13). Study of the soil classification data (Table 2) indicates that the soils in portions of towns 16, 19, and 23 were shallower than the $\geq$ 30-in.-depth criteria used to map the potential habitat areas. Thus, except for towns 16, 19, and 23, the soil factor classes that were mapped should have included all the existing habitats.

39. The detailed vegetation data (Tables P3 and P4, Appendix P) that resulted from the short field sampling program in prairie dog towns 1-7 (Appendix P) indicated that the plant species in those towns were characteristic of short- and mixed-grass prairies (see paragraph 9, Appendix P). Therefore, the factor class range established for vegetation (short- and mixed-grass prairie species) should have included all the existing habitats. In summary, the WES concluded that the factor class ranges established for slope, soil, and vegetation should have encompassed all the existing habitats for the black-tailed prairie dog.

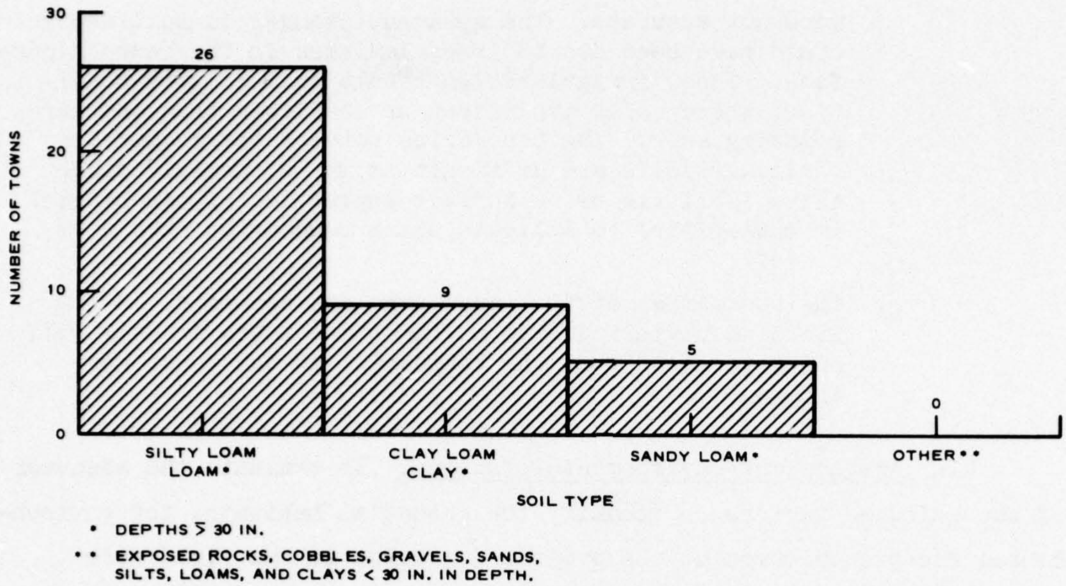


Figure 13. Influence of soil type on prairie dog town location, Fort Carson, Colorado

40. Mapping evaluation. The WES compared the mapping criteria for potential habitats to the actual values for the environmental factors in towns 16, 19, and 23 (Table 3). This comparison indicates that the reason that portions of the three towns were not included in the areas identified as potential habitat is that some soils in the three towns were shallower than the soil depth criteria used to map potential habitats. The WES did not consider changing the mapping criteria to the shallowest depth (12 in.) since 93 percent of the towns were correctly identified as occurring in soils ≥ 30 in. in depth. The specific reason(s) that portions of the three towns appeared to exist on the shallower soils was not determined but could have been due to one or more of the following:

- a. The boundaries of the soil types were not accurate on the WES soils map. The SCS soils maps used as the data base were uncontrolled photomosaics. Such mosaics are known to contain several sources of error, including longitudinal and latitudinal displacement and distortion. The transfer from the mosaics to the WES map could have introduced errors.
- b. The boundaries of the soil types on the SCS photomosaics

were not accurate. The apparent changes in soil depths could have been due to irregularities in the bedrock surface. These irregularities result in localized conditions where soils are deeper or shallower than the surrounding area. The boundaries between the deeper or shallower soils are difficult to map accurately since there is little or no surface expression of the bedrock irregularities to indicate where boundaries should be placed.

c. The boundaries of the towns were not accurate. A WES field team visited each of the three towns in July 1977 and determined that the boundaries of the towns were accurate.

41. Adequacy of environmental factors. To evaluate the adequacy of the selected factors to identify the potential habitats, the environmental factors observed at the prairie dog towns in the field were noted and compared with those reported in the literature; a close similarity existed. Further, upon comparison of the values reported for the environmental factors in the literature to the values for the same factors obtained in the existing towns (Table 4), the data show that with the exception of vegetation height, all of the values for the habitat requirements in the existing towns were within the reported literature values. The actual vegetation height in town 4 was 30 cm greater than the maximum height reported in the literature. Since vegetation height was not one of the mapping factors used in the habitat mapping procedure, the difference between the literature-reported and actual heights could not be responsible for the fact that three of the towns (16, 19, and 23) were not included in the potential habitat area (see paragraph 32).

42. Since the existing prairie dog towns (active and abandoned) occur on only 5,000 (7 percent) of the 70,000 acres identified as potential habitat areas, consideration of additional environmental factors may be desirable to better refine the potential habitat map. Preliminary analysis of the topographic factors (Figure 12), including topographic relief, average elevation, slope range, and in particular average downslope azimuth, indicated that additional factors that might influence habitat selection by the prairie dog could be used and thereby

provide a more refined potential habitat map.

Potential mule deer habitats

43. The mule deer, the second species selected to test the habitat identification and mapping procedures, is a mobile species and may have a home range (i.e. the area within which an individual or family tends to confine its activities), measuring from 4 to 7 km^2. Within this home range, family groups will normally have day-and-night feeding areas, day-and-night bedding areas, early-morning and late-afternoon watering areas (summer only), and numerous travel lanes connecting these activity areas. The locations of the activity areas as used by the mule deer change appreciably with changing seasons, local weather conditions, and the type and duration of human-related activities being conducted in or near a particular home range. In addition to the above activity areas, the deer also use "hiding areas" for shelter against predators and for rearing their offspring (a detailed description of preferred habitat conditions of the mule deer is in Appendix B).

44. The activity areas used by the mule deer are very localized and constitute "microenvironments" (see paragraph 16). The sizes of the microenvironments of the mule deer are definitely larger than those of the prairie dog, but they are still quite small in comparison to the area occupied by the home range.

45. Identification of habitat requirements. A geographic area that would be considered potential mule deer habitat would have to contain the environmental factors (habitat requirements) that define mule deer feeding areas, bedding areas, water areas, travel lanes, and hiding areas. These factors, which were reported in the literature, are summarized in the mule deer narrative (Appendix B) and are listed in Table 5.

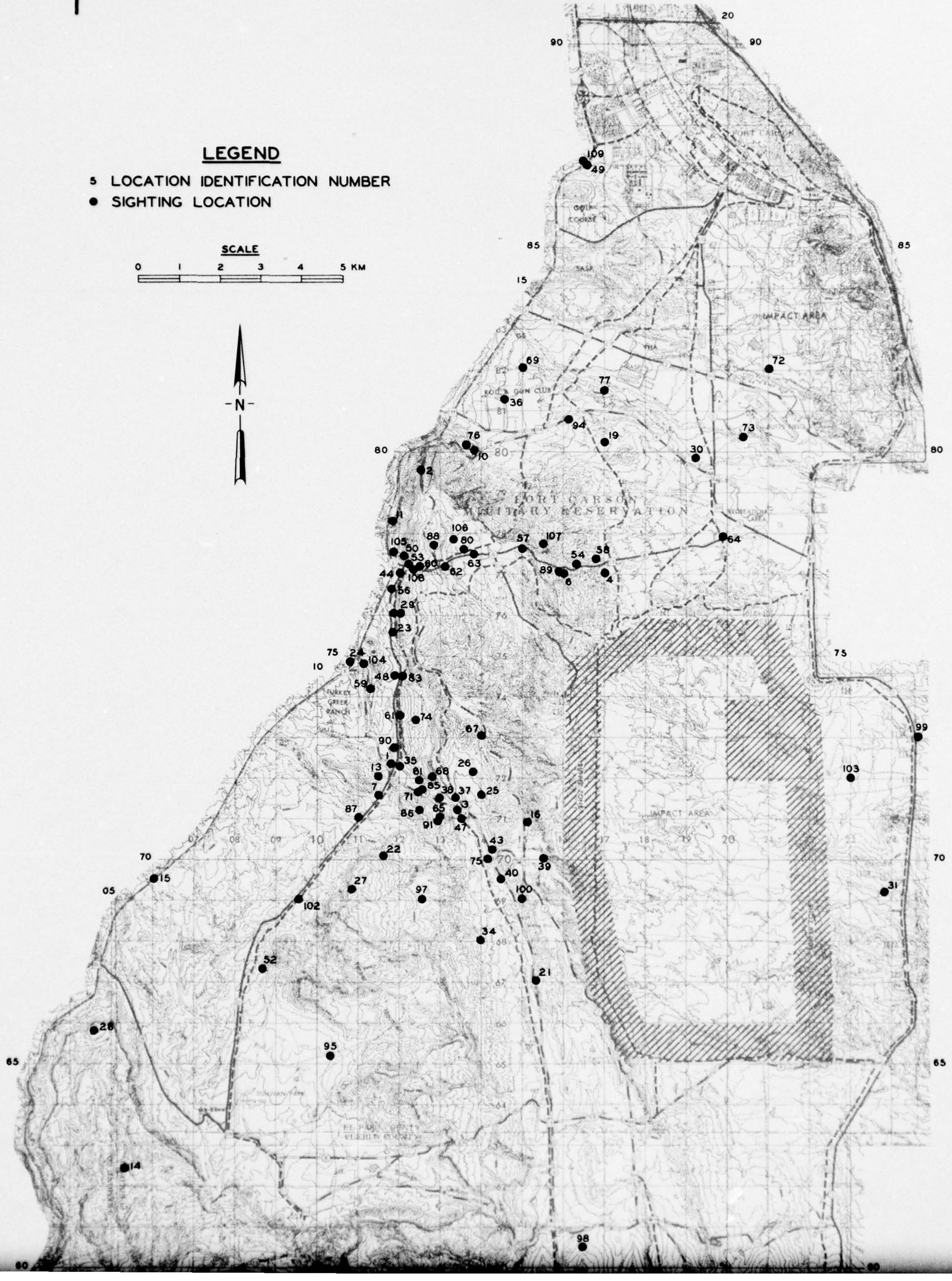
46. In addition to the environmental factors that define the habitat requirements, a number of environmental factors, behavior modifying factors (Table 6), influence the mule deer's choice (during one 24-hr period) of an activity area within its home range.

47. Locating and mapping habitat requirements. The number of

factors hypothesized (Tables 5 and 6) to be of importance to mule deer are quite numerous, and it would be impractical to consider all of them equally in the "potential habitat" mapping procedure as was done for the prairie dog. The WES performed a literature search to obtain data on the environmental factors that define the activity areas and modify the mule deer's choice of those areas (Appendix B). This search, however, yielded insufficient quantitative data to rank the relative importance of the factors. For this reason, criteria for quantitatively mapping the deer habitats could not be developed within the scope of the study. Consequently, because of the importance of the mule deer to the Fort Carson ecosystem, the Land Management Branch, DFAE, has requested further studies be conducted on the deer habitat to determine the effects of military range training operations on the mule deer at Fort Carson. An integral part of the recommended study is the acquisition of quantitative data on the habitat requirements of the mule deer and the correlation between deer activity and the microenvironments. Further, a map of Fort Carson indicating the potential habitat areas, using the habitat identification and mapping procedures, is desired.

48. To assist in the selection of an area of Fort Carson for the proposed study, the WES prepared mule deer sighting maps. Data pertaining to the sightings of mule deer species on the Fort Carson Reservation were collected by reservation wildlife personnel from March 1974 through April 1976 by driving along the various roads during both daytime and nighttime periods. The following data categories were recorded: (a) the military coordinate locations of the sightings, (b) the time (2300-hr clock) of the sightings, and (c) the number of animals at the sighting locations. Of these data, the number of deer and the date and time of sighting are tabulated in Tables 7 and 8. The data on the military coordinate locations enabled WES personnel to depict the sightings on two Fort Carson 1:50,000-scale maps (Figures 14 and 15).

49. The sighting data for the period May 1975-April 1976, when analyzed in terms of time of occurrence (Figures 16 and 17), reveal that most of the sightings occurred during the spring season (March, April,

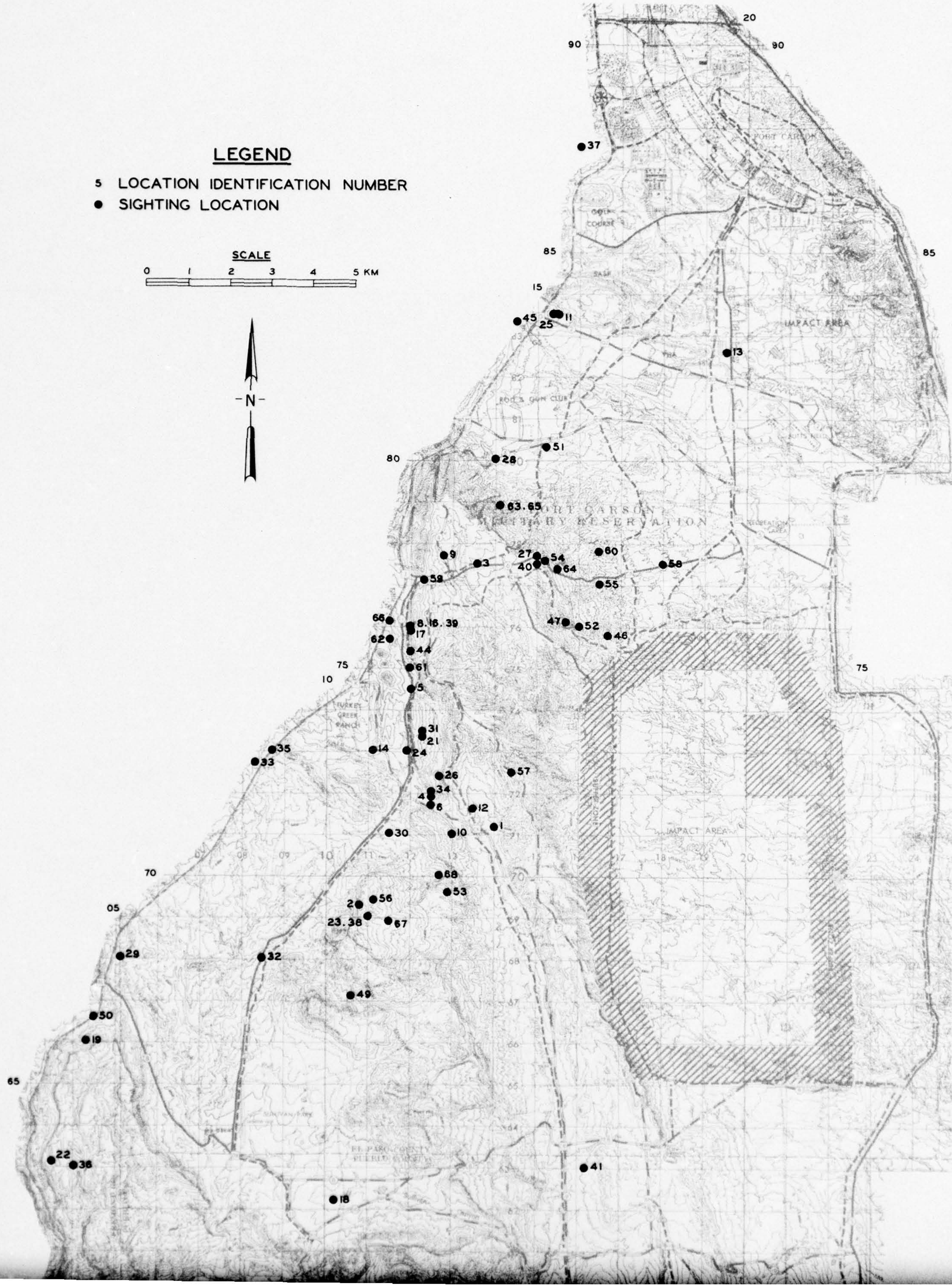


LEGEND
5 LOCATION IDENTIFICATION NUMBER
● SIGHTING LOCATION
SCALE
0 1 2 3 4 5 KM
N
FORT CARSON MILITARY RESERVATION
IMPACT AREA
TURKEY CREEK RANCH
EL PASO COUNTY
PUEBLO COUNTY

Figure 14. Mule deer sightings for the period March 1974-June 1975 on the Fort Carson Reservation

2

1


LEGEND
5 LOCATION IDENTIFICATION NUMBER
● SIGHTING LOCATION
SCALE
0 1 2 3 4 5 KM
N
FORT CARSON
IMPACT AREA
FORT CARSON MILITARY RESERVATION
IMPACT AREA

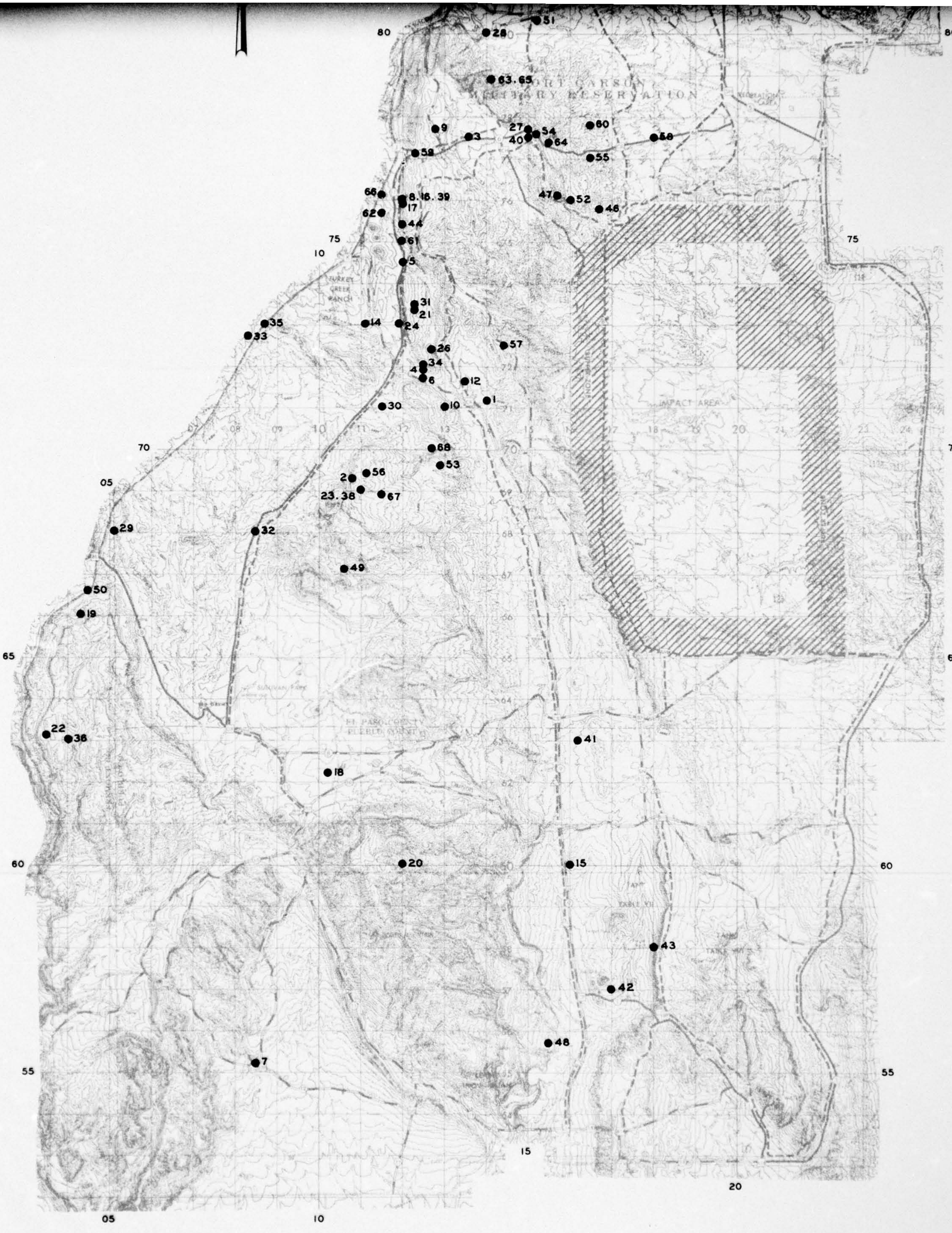


Figure 15. Mule deer sightings for the period May 1975-April 1976 on the Fort Carson Reservation

2

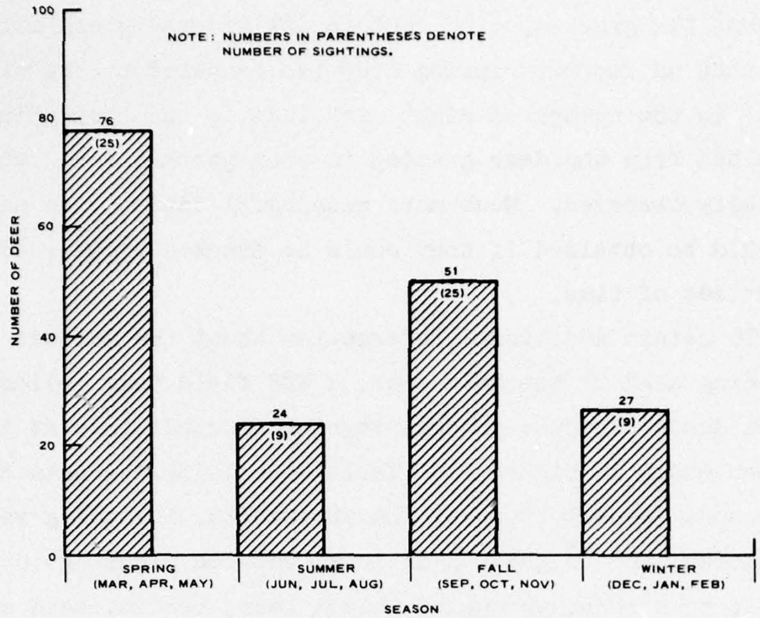


Figure 16. Seasonal population and sightings of mule deer at Fort Carson, Colorado, May 1975-April 1976

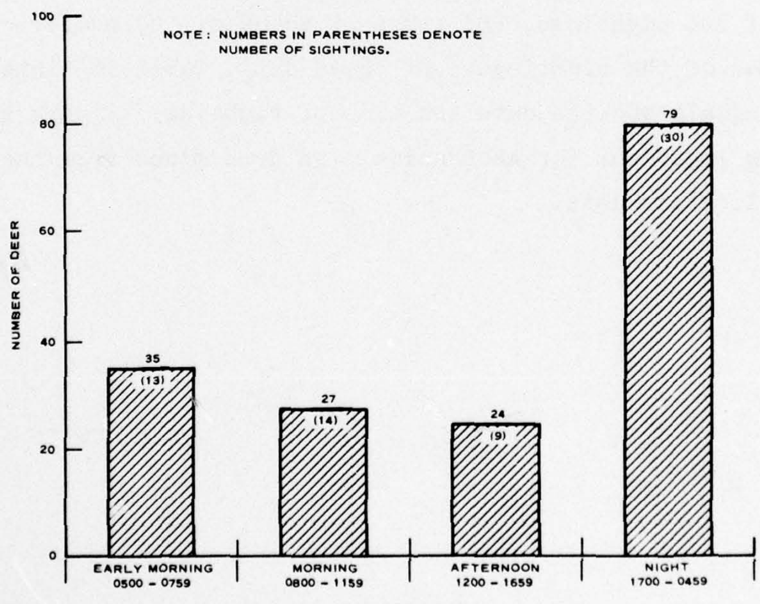
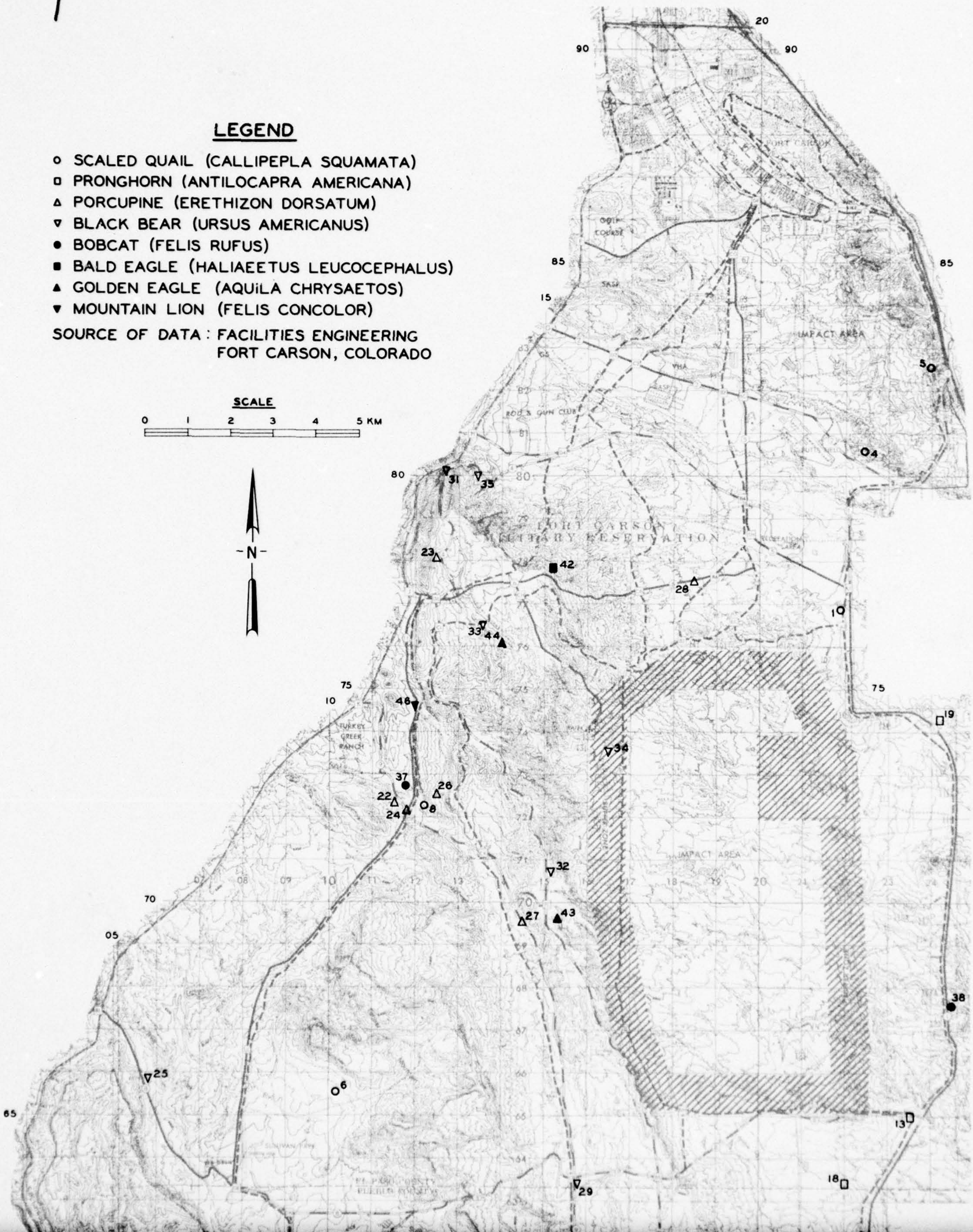


Figure 17. Diurnal population and sightings of mule deer at Fort Carson, Colorado, May 1975-April 1976

and May) and during the nighttime (1700-0459 hr) period. During the spring season, the grass species contain new growth (green material), which furnishes an improved spring diet (as compared to the winter diet). The increase in the number of night sightings in the springtime almost surely resulted from the deer grazing in open pasture areas where they could be easily observed. Much more meaningful data on the deer activity could be obtained if they could be tracked unobserved over extended periods of time.

50. To obtain additional information about the habitat areas that were being used by the mule deer, a WES field team collected limited data describing the general vegetation conditions at the sighting locations shown in Figure 14. Table 9 contains the data that represent general descriptions of the vegetation, including vegetation species, spacing, and height. Additional data on sightings of the scaled quail, pronghorn, porcupine, black bear, bobcat, bald and golden eagles, and mountain lion were collected by the Fort Carson wildlife personnel during the period April 1974 through June 1975. The data that were recorded consisted of the following: (a) military coordinate locations of the sightings, (b) types of animals, (c) number of animals, and (d) times of the sightings. Of these data, Table 10 lists the number of animals and the date and time of sighting. Figure 18 depicts the sighting locations for each animal, as determined from the military coordinate location data.

1


LEGEND
○ SCALED QUAIL (CALLIPEPLA SQUAMATA)
□ PRONGHORN (ANTILOCAPRA AMERICANA)
△ PORCUPINE (ERETHIZON DORSATUM)
▽ BLACK BEAR (URSUS AMERICANUS)
● BOBCAT (FELIS RUFUS)
■ BALD EAGLE (HALIAEETUS LEUCOCEPHALUS)
▲ GOLDEN EAGLE (AQUILA CHRYSAETOS)
▼ MOUNTAIN LION (FELIS CONCOLOR)
SOURCE OF DATA: FACILITIES ENGINEERING
FORT CARSON, COLORADO
SCALE
0 1 2 3 4 5 KM
N
FORT CARSON MILITARY RESERVATION
IMPACT AREA
ROD & GUN CLUB
TURKEY CREEK RANCH

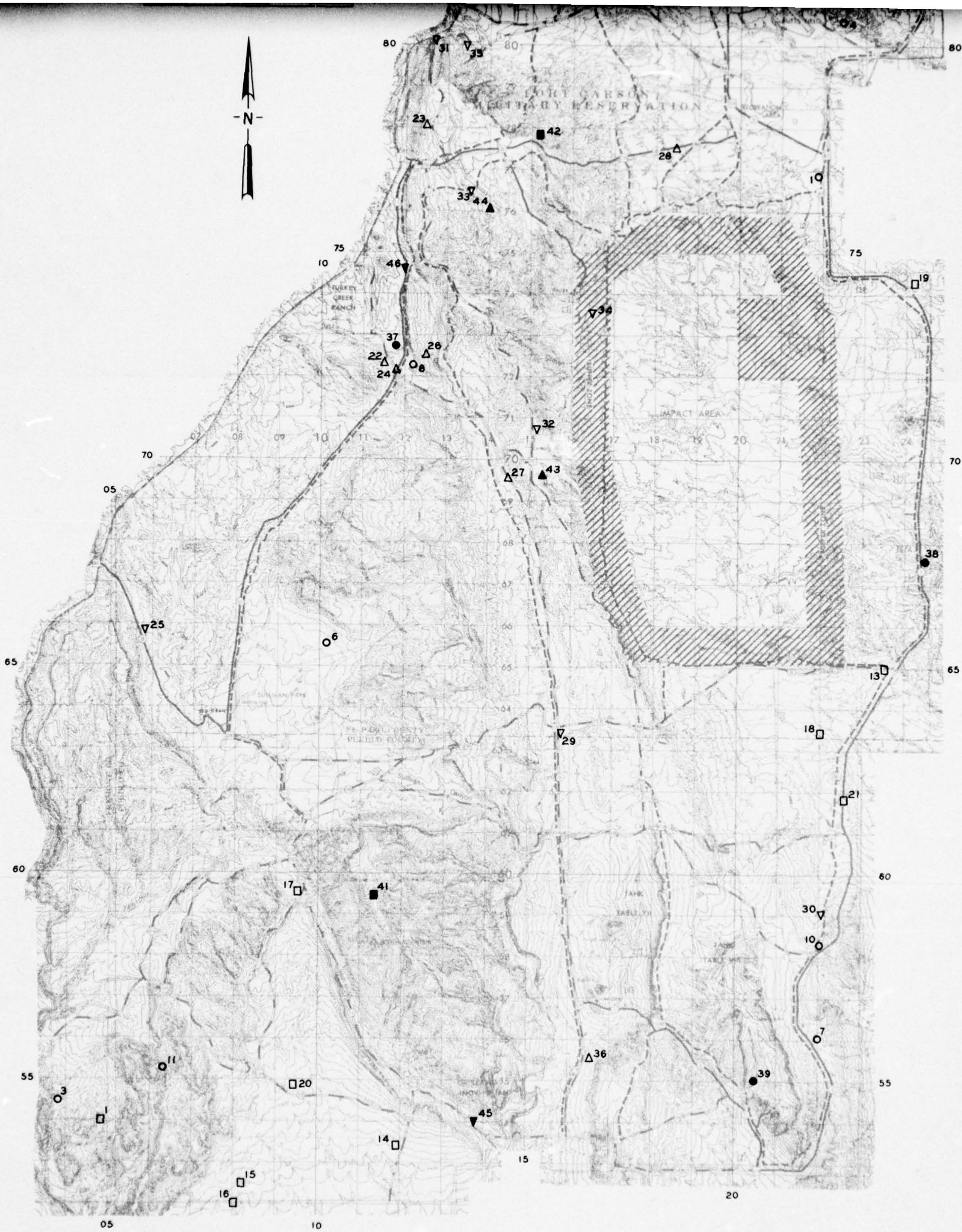


Figure 18. Wildlife sightings for the period May 1974-June 1975
on the Fort Carson Reservation

2

PART IV: USE OF WILDLIFE AND WILDLIFE HABITAT DATA

Wildlife Narrative Accounts

51. The wildlife narrative accounts provide the facilities engineer with specific data on the habits and habitats of wildlife. The facilities engineer can use these data to assist in the achievement of the objectives of his wildlife management plan (see paragraph 6). Two examples, i.e. improved management of the pronghorn and Abert's squirrel, will serve to illustrate the use of these data.

Management of the pronghorn

52. One desirable objective of the facilities engineer in management of the pronghorn is to increase the harvestable herd on the installation for recreational purposes. A review of the narrative account (Appendix C) for this species shows that pronghorns prefer open country, primarily open plains and broader interior valleys, with family groups occupying an area of a few hundred acres. They eat the foliage and twigs of woody plant species with sagebrush predominating. Oats and alfalfa crops and salt licks attract the pronghorn. The pronghorn avoids other hoofed animals; coyotes, mountain lions, and bobcats can be a threat to both adults and young. Areas where sheep, cattle, and horses have grazed are avoided, while timbered areas are used for escape cover. Surface water supplies are not required. Trapping and transporting are effective methods to introduce the species into new areas.

53. These facts indicate that management techniques available to the facilities engineer could include: (a) providing a mixture of open country and timbered areas for habitat by clear-cutting selected areas of the installation in order to have more open areas of a few hundred acres in size; (b) increasing the amount of woody plant species by selective planting of the preferred species; (c) attracting and holding more pronghorns on the installation by planting oats and alfalfa and providing salt blocks; (d) removing competing hoofed animals by eliminating leases for grazing rights on the installation; (e) controlling

predators by allowing predator hunters on the installation; and (f) increasing the number of resident pronghorns by trapping in areas where they are more abundant and releasing them on the installation.

Management of the Abert's squirrel

54. A likely management objective of the facilities engineer with regard to the Abert's squirrel* is to restore, improve, and preserve the existing habitat on the installation. A review of the narrative account on this species (Appendix L) shows that this animal is restricted to stands of ponderosa pine (a species that occurs on Fort Carson), which provide the squirrel with food and cover. Ponderosa pines having an 11- to 30-in. diameter at breast height, with crown densities of more than 70 percent, are preferred. The increase or decrease of the squirrel population is related to ponderosa pinecone formation, with more squirrels in the years of greater pinecone production.

55. Management techniques available to the facilities engineer include: (a) preserving existing stands of ponderosa pine by preventing logging activities and training exercises where the pines occur; (b) improving the number and extent of ponderosa pine by planting the pines; (c) increasing the cone production of individual stands by application of fertilizer; and (d) restoring productivity of existing stands by spraying the trees for disease and insect control.

Wildlife Habitat Maps

Plague control and eradication

56. The utility of having a map showing existing and potential habitats of an animal was evident during the spring and summer of 1976 when an epizootic plague was discovered within the prairie dog towns on Fort Carson. The plague (caused by the bacillus *Yersinia pestis*) is carried from animal to animal and from animal to man by flea vectors (on Fort Carson, the fleas involved were *Xenopsyha cheophis* and

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* The Abert's squirrel is a species that is protected in several states and also is highly desirable for its aesthetic qualities.

Nosopsyllus fasciatus). The disease is fatal to prairie dogs and can be fatal to man. By the use of literature data on the average number of prairie dog burrows per acre (40) and the average number of animals of breeding age per acre (5), it was estimated that on May 1976 the Fort Carson Reservation contained approximately 25,000 prairie dogs (breeding population only).

57. The Fort Carson plan (developed in June 1976) to control and eradicate the plague had two main objectives: (a) prevent the possibility of military personnel becoming infected by stopping all military training being conducted in the vicinity of known infected prairie dog towns, and (b) eradicate the flea vectors by treating (dusting) all burrows within the 40 active towns with an insecticide. The existence of the WES-prepared habitat map showing existing towns and potential habitat areas considerably reduced the time, cost, and disruption of normal training activities incurred by Fort Carson in implementing this plan. The map was used to prevent human infection by serving as a basis for controlling training activity in the area, to determine the amount of insecticide and personnel needed for the dusting, and to schedule the dusting teams.

Prevention of human infection

58. All training activities in the immediate vicinity of infected prairie dog towns were halted to prevent human infection. Entomologists, organized into surveillance teams, determined which towns were infected. One surveillance team was responsible for both pretreatment and posttreatment (after dusting) counts of the fleas in the various prairie dog towns. This was for the purpose of determining whether or not the towns were infested with fleas (pretreatment) and also to determine the effectiveness (posttreatment) of the dusting operation (see paragraphs 62-64). Fifty burrows within each of the 40 towns were selected for determination of the two flea counts. The fleas were collected with a 12- by 12-in. piece of white cloth attached to the end of a 10-ft flexible cable (Figure 19). The cloth was inserted into the tunnel of the burrow for approximately 4 to 8 ft (Figure 20), pulled back out, quickly inspected for the presence of fleas

Figure 19. Cloth attached to flexible cable

Figure 20. Inserting cloth into tunnel of a burrow for collection of flea specimens

(Figure 21), and then placed into a polyethylene bag (Figure 22). The bag was then transferred to the laboratory at Fort Carson. At the laboratory, the fleas were counted, placed in vials, and sent to the Communicable Disease Center (CDC) laboratory at Fort Collins, Colorado. The CDC laboratory determined whether the fleas were infected with the plague.

Determination of amount of insecticide needed

59. The WES-prepared habitat map (Figure 9), showing the locations and areal extents of the prairie dog towns on the Fort Carson Reservation, was used to determine the amount of carbaryl dust needed for dusting the towns. Based on the WES habitat map and the baseline data on the number of burrows per town that was collected within selected towns, it was determined that approximately 1,000 lb of 5 percent and 14,000 lb of 10 percent carbaryl dust (i.e. 5 and 10 percent Sevin dust, respectively) were needed for the complete dusting operation. Once this determination was made, the chemicals were obtained by emergency purchasing action and received at Fort Carson within a few days after the order had been placed.

Determination of number of personnel needed

60. The WES had supplied Fort Carson with an estimate of the total acres in each prairie dog town (Table 1). Based on those figures and the desire to complete the dusting operation within a month, Fort Carson assembled the following personnel to conduct the dusting operation:

a. Personnel of the Medical Department Activity, Fort Carson, Colorado.

b. Veterinary and wildlife consultants, Fort Carson, Colorado.

c. Enlisted military personnel, Fort Carson, Colorado.

d. Entomology consultants from the U. S. Army Environmental Hygiene Agency, Fitzsimmons Army Medical Center, Denver, Colorado.

e. A preventative medicine medical detachment, Fort Bragg, North Carolina.

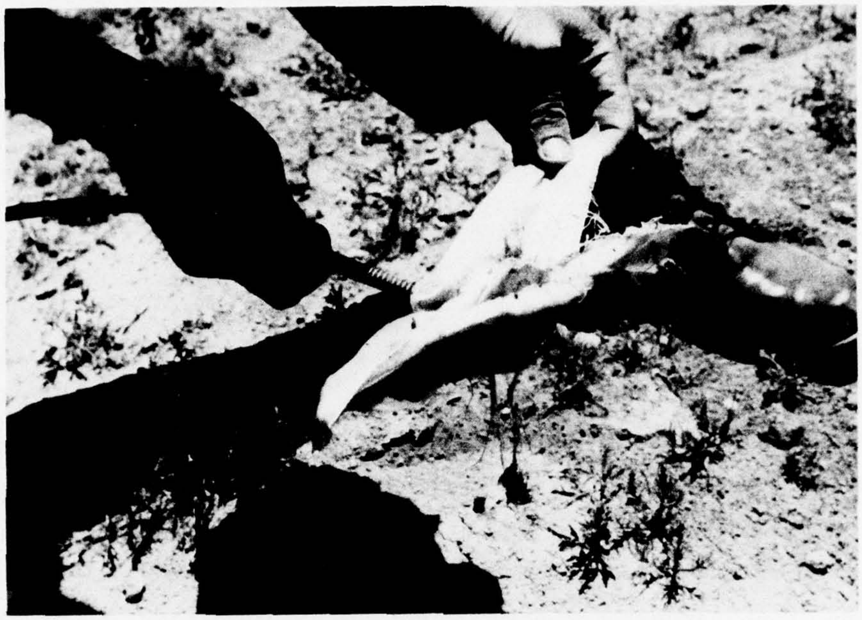

Figure 21. Inspection of cloth for fleas

Figure 22. Cloth with fleas being placed into polyethylene bag for transfer to laboratory

f. A preventative medicine medical detachment, Fort Sam Houston, Texas.

Scheduling the dusting teams

61. Based on the habitat map and the ability to dust 300 to 400 acres per day, Fort Carson was able to schedule the dusting teams to most efficiently use the available time. The dusting procedure is described below.

Dusting procedure

62. A reconnaissance team (six people) was responsible for laying out the areas of towns that were to be dusted. Moving ahead of the dusting teams and using the WES habitat map, the reconnaissance team divided the towns into several 500-ft-wide parallel transects or strips. These strips were marked with wooden stakes and colored ribbon for good visibility by the dusting team.

63. Two 40- to 50-man teams, with a day's supply of carbaryl dust on a vehicle and each person with a rotary-action drum-type dusting machine (Figure 23), performed the dusting operation. Dusting began on 11 June 1976. The procedure consisted of aligning the dusting team (personnel at 10- or 12-ft spacings) along a line perpendicular to a marked strip (Figure 24) and then moving the team at a fairly constant rate to cover the strip. The dusting team was instructed to insufflate approximately 2-oz carbaryl dust into the opening of each burrow that was encountered within the town (Figure 25). Figure 26 shows a dusted burrow.

64. The dusting operation was considered by Fort Carson to be a total success, and the WES habitat data proved to be vital in the planning and carrying out of the dusting operation. The availability of the WES habitat data minimized the cost of the dusting operation and helped prevent infestation of military personnel.

65. As a result of the plague, the population of prairie dogs has been drastically reduced on the Fort Carson Reservation. The approximate present (May 1977) population of the animals on the reservation should be determined by revisiting each of the 40 existing towns (Figure 9) that were located and mapped by WES to determine which towns now contain live animals.

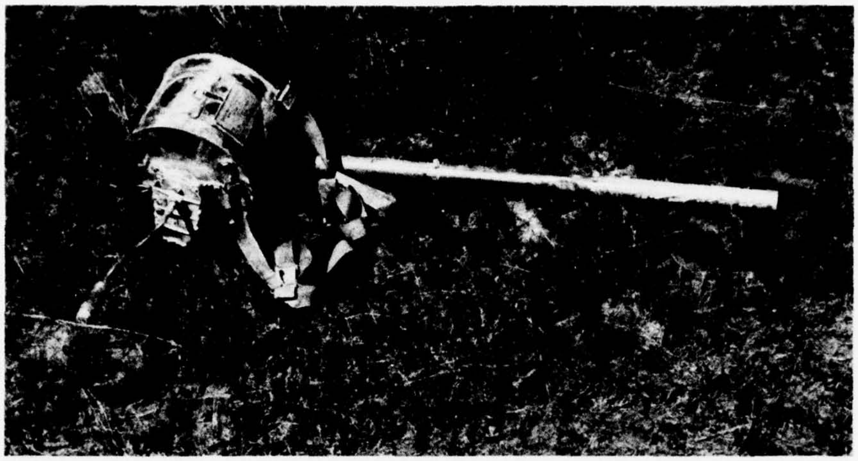

Figure 23. Rotary-action, drum-type duster

Figure 24. Personnel with dusters beginning dusting operation

Figure 25. Dusting operation in progress

Figure 26. Dusted burrow

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

66. The following conclusions can be summarized from the study. The procedure used to develop narrative accounts provides data in a format suitable for wildlife management use by Army facilities engineers (see paragraph 12). The narrative account is an effective and efficient method of presenting data on the habits and habitat requirements of wildlife.

67. The five-step habitat mapping procedure that was developed during this study was applied successfully to identify potential habitat of the black-tailed prairie dog on Fort Carson (see paragraph 27). The habitat requirements listed in the prairie dog narrative account have proved to be adequate for mapping potential habitats of the prairie dog (see paragraph 39). Specific findings of this study indicate that:

- a. Photography at a scale at least as large as 1:20,000 is required to identify prairie dog towns (see paragraph 30).
- b. There were 40 active and 3 abandoned prairie dog towns on Fort Carson. The active towns cover 5000 acres (7 percent) of Fort Carson (Figure 9).
- c. An analysis of existing towns indicates that they were situated in areas, with the following environmental factor values:
  - (1) Elevation (40 towns): 1658-1951 m (Table 1)
  - (2) Weighted mean slope (40 towns): 0.8-3.7 deg (Table 1)
  - (3) Vegetation type (7 towns): short- and mixed-grass prairie species (Table P3)
  - (4) Vegetation height (7 towns): 2-60 cm (Table P5)
  - (5) Vegetation cover (7 towns): 10-40 percent (Table P5)
  - (6) Soil type (40 towns): deep cohesive soils (Table 2)
  - (7) The literature-reported values for these parameters were accurate and adequate for mapping potential habitat (see paragraph 41).

(8) The potential habitat for the prairie dog on Fort Carson covers 70,000 acres or 52 percent of Fort Carson (see paragraph 27).

68. The habitat mapping procedure could not be applied to the identification of mule deer habitats within the time frame of the study because the literature search for the habitat requirements did not yield sufficient quantitative data to permit the establishment of practical mapping criteria.

69. The data in the narrative accounts can be used to help select the management techniques that will achieve the desired management objectives (see paragraphs 48 and 50).

70. The habitat map for the black-tailed prairie dog was effectively used for:

a. Planning training activities in areas where plague-infected prairie dog towns did not exist (see paragraph 58).

b. Determining the amount of insecticide needed to dust the prairie dog towns (see paragraph 59).

c. Determining the number of personnel required to dust the towns (see paragraph 60).

d. Scheduling the dusting teams (see paragraph 61).

e. Keeping the cost of the dusting operation to a minimum (see paragraph 64).

Recommendations

71. In order to further provide the facilities engineer with data to more adequately manage the wildlife resources at Fort Carson, it is recommended that:

a. Additional narratives be prepared for other wildlife species as soon as the need to manage those species is identified.

b. The existing habitats for the wildlife listed in paragraph 10 be identified and mapped so that potential conflicts between an area's use as a training site and its use as a wildlife habitat can be anticipated.

c. Data development on the mule deer be continued. Future study should include field study of the deer's relationship to its habitat and study of the effects of military range operation on mule deer activity.

d. Additional work be done to update the WES prairie dog habitat map (Figure 9) to determine the towns that no longer contain live animals as a result of the plague.

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Table 1

Topographic Data on Prairie Dog Towns, Fort Carson, Colorado

Town Identification No.	Area, m^2	Topographic Relief, m	Average Elevation m	Average Downslope Azimuth deg, N = 0^o	Slope Range deg	Weighted Mean Slope deg
1	2,983,700	61	1658	198	0.7-3.6	1.5
2	548,400	24	1689	90	1.2-2.9	1.7
3	387,100	11	1696	95	0.6-3.6	1.1
4	983,700	12	1765	255	0.8-2.9	1.3
5	500,000	24	1951	180	1.1-2.6	1.8
6	1,096,800	12	1945	151	1.9-5.7	1.6
7	1,016,100	12	1756	230	0.4-7.1	0.9
8	112,900	9	1769	220	3.0-4.8	3.7
9	145,200	12	1899	170	1.5-5.7	2.4
10	1,903,000	73	1865	190	0.9-5.7	2.3
11	225,700	24	1847	230	2.0-2.6	2.2
12	467,500	12	1862	220	1.0-3.8	1.5
13	483,700	31	1887	150	1.0-2.9	1.3
14	145,000	18	1817	205	1.4*	1.4
15	677,200	24	1722	155	0.9-1.4	1.1
16	1,741,700	52	1780	140	0.6-5.7	1.1
17	193,500	20	1734	250	1.7-3.2	2.3
18	241,700	27	1716	125	2.6-3.6	3.0
19	370,750	29	1692	175	0.8-4.8	1.8
20	161,200	27	1734	125	1.7-2.2	1.9
21	354,700	32	1716	260	1.7-2.6	2.0
22	209,500	26	1765	115	1.4-3.6	2.1
23	112,900	26	1725	180	1.4-2.4	1.9
24	80,500	24	1932	115	3.6-3.8	3.7
25	225,700	24	1881	130	1.9-6.3	3.3
26	661,200	49	1844	170	0.9-3,4	1.4
27	516,000	20	1841	160	0.7-4.1	0.8
28	387,000	24	1771	220	1.1-2.9	1.9
29	258,100	30	1752	210	0.6-6.3	1.7
30	48,200	3	1766	140	0.9*	0.9
31	645,000	37	1722	205	1.9-7.1	2.4
32	96,800	18	1703	55	0.7-1.9	1.1
33	451,600	18	1703	60	0.9-9.5	1.4
34	274,200	12	1823	275	2.0-4.8	3.1
35	354,800	24	1676	270	1.5-2.5	2.9
36	129,000	6	1813	290	0.7-1.8	1.0
37	258,000	18	1715	115	0.6-1.3	0.8
38	64,500	6	1929	60	2.9-4.4	3.6
39	306,250	18	1777	155	1.3-4.4	2.1
40	145,200	1	1792	70	1.5*	1.5

* Only one transect line segment was used (see paragraph 36).

Table 2

Soils Classifications in Prairie Dog Towns, Fort Carson, Colorado

Town Identification No.	Minimum Soil Depth in.	USDA Textural Soil Classification	USGS Designation
1	60	Silty loam	CL
	32	Loam	ML-CL
2	58	Loam	ML-CL
	48	Clay	CH
3	60	Loam	ML,SM,CL
4	60	Loam	ML
	30	Clay	CH
5	60	Sandy loam	SM,CL,ML
6	60	Loam	ML,CL
7	60	Silty loam	CL
	60	Loam	SM,CL
8	60	Clay loam	CL,CH
9	60	Sandy loam	SM,ML
10	60	Loam	ML-CL,SM,CL
11	60	Loam	CL-ML,CL
12	60	Loam	ML,CL
13	60	Loam	ML,CL
14	60	Loam	CL-ML,CL
15	60	Clay loam	CL
16	60	Silty loam	CL
	12	Loam	ML
17	60	Silty loam	CL
18	48	Loam	ML-CL
19	32	Loam	ML-CL
	12	Loam	ML
20	60	Silty loam	CL
21	48	Loam	ML-CL
22	48	Loam	ML-CL

(Continued)

Table 2 (Concluded)

Town Identification No.	Minimum Soil Depth in.	USDA Textural Soil Classification	USGS Designation
23	48	Loam	ML-CL
	16	Clay loam	CH
24	60	Clay loam	CL
25	60	Clay loam	CL
26	60	Sandy loam	SM,ML
27	60	Sandy loam	SM
28	48	Loam	ML-CL
29	60	Clay loam	CL
30	60	Loam	ML,CL
31	40	Clay loam	CL,CL-SM
32	60	Loam	CL
33	60	Sandy loam	SM
34	60	Loam	CL-ML,CL
35	60	Loam	ML,SM,CL
36	60	Loam	CL-ML,CL
37	60	Loam	ML,SM,CL
38	60	Clay loam	CL-SC
39	30	Clay loam	CL,CH
40	60	Clay loam	CL,ML-CL

Table 3

Comparison Between Mapping Criteria for Potential Habitats and Actual Values for Environmental Factors in Three Towns Not Included in Areas Identified as Potential Habitat for the Black-Tailed Prairie Dog

Environmental Factor	Mapping Criteria for Potential Habitats	Actual Conditions in Town	Percent of Town Area
	Town 16		
Slope	0 - 10 deg	0.6 - 5.7 deg	100
Soil	Loam and silty loam $\overline{>}$ 30 in. in depth	Silty loam 60 in. in depth	82
	Clay and clay loam $\overline{>}$ 30 in. in depth	Loam 12 in. in depth	18
	Sandy loam $\overline{>}$ 30 in. in depth		
Vegetation	Short- and mixed-grass Prairie species	Short- and mixed-grass Prairie species	100
	Town 19		
Slope	0 - 10 deg	0.8 - 4.8 deg	100
Soil	Loam and silty loam $\overline{>}$ 30 in. in depth	Loam 32 in. in depth	62
	Clay and clay loam $\overline{>}$ 30 in. in depth	Loam 12 in. in depth	38
	Sandy loam $\overline{>}$ 30 in. in depth		
Vegetation	Short- and mixed-grass Prairie species	Short- and mixed-grass Prairie species	100
	Town 23		
Slope	0 - 10 deg	1.4 - 2.4 deg	100
Soil	Loam and silty loam $\overline{>}$ 30 in. in depth	Loam 48 in. in depth	50
	Clay and clay loam $\overline{>}$ 30 in. in depth	Clay loam 16 in. in depth	50
	Sandy loam $\overline{>}$ 30 in. in depth		
Vegetation	Short- and mixed-grass Prairie species	Short- and mixed-grass Prairie species	100

Table 4

Comparison Between Literature-Reported and Actual Environmental Factors in 40 Black-Tailed Prairie Dog Towns

Environmental Factor	Value for Factor Reported in Literature	Value for Factor in Existing Towns
Elevation	<2800 m	1658-1951 m
Slope	0-10 deg	0-9.5 deg (range) 0-3.7 deg (weighted mean)
Vegetation type	Short- and mixed-grass species	Short- and mixed-grass species
Vegetation height	<30 cm	2-60 cm
Vegetation cover	5-50%	13-41%
Soil type	Deep cohesive soils	Deep cohesive soils

Table 5

Environmental Factors of Mule Deer Habitat

Feeding Areas

Species and volume of woody forage within 2 m of ground
Species and volume of nonwoody forage
Species and volume of mast (acorns)
Horizontal visibility
Slope magnitude
Slope aspect
Snow depth
Location and size of salt deposits

Bedding Areas

Type and depth of ground cover
Horizontal visibility
Slope magnitude
Slope aspect
Snow depth

Hiding Areas

Horizontal visibility
Slope magnitude
Snow depth

Watering Areas (Summer only)

Location of freewater sources
Horizontal visibility
Slope magnitude
Snow depth

Travel Lanes

Location of physical barriers
Width of physical barriers
Height or depth of physical barriers
Horizontal visibility
Snow depth

Table 6

Behavior Modifying Factors that Influence Mule Deer Selection of One Activity Area (Feeding, Bedding, etc.) Over Another Area (Feeding, Bedding, etc.)

Areal extent and location of roads, airfields, buildings, and firing ranges
Location and level of noise from predators
Location and level of noise from man-induced sources
Air temperature
Wind direction
Wind speed
Rainfall
Snowfall
Light intensity (day and night)
Barometric pressure
Relative humidity
Location and age of bucks
Location and age of does
Distance to nearest hiding area
Distance to nearest feeding area
Distance to nearest bedding area
Distance to nearest watering area
Percent of available forage that is preferred
Time of year
Time of day
Location of other family groups
Location of other buck groups
Location of home range boundary of that family group
Volume of forage consumed by competing herbivores

Table 7

Data on Mule Deer Sightings for the Period March 1974-June 1975, Fort Carson, Colorado*

Sighting No.	Number of Deer	Date of Sighting	Time of Sighting, hr
1	1	24 Aug 74	0930
2	6	21 Aug 74	2210
3	3	21 Aug 74	2115
4	2	1 Sep 74	2145
5	2	15 Sep 74	0410
6	1	9 Sep 74	0300
7	2	30 Oct 74	1210
8	3	30 Oct 74	1210
9	4	30 Oct 74	1210
10	1	9 Oct 74	0800
11	1	18 Sep 74	0410
12	3	16 Sep 74	2000
13	2	17 Sep 74	2030
14	3	20 Apr 75	1500
15	3	9 Feb 75	1800
16	3	27 Apr 75	2335
17	2	19 Spr 74	2230
18	4	19 Apr 74	0230
19	1	25 Apr 74	1100
20	1	24 Apr 74	0130
21	2	10 May 74	2100
22	2	10 May 74	0630
23	1	10 May 74	1530
24	2	10 May 74	0715
25	4	7 May 75	0620
26	2	7 May 74	0630
27	1	7 May 75	0710
28	2	16 May 74	2330
29	1	17 May 74	1330
30	1	25 Jun 74	2130
31	2	24 Jun 74	0630
32	2	25 Jun 74	0010
33	3	22 Jun 74	2210
34	6	25 Apr 74	2220
35	1	27 Jun 74	0920
36	2	27 Apr 74	2300
37	5	2 Jun 74	--
38	1	2 Jun 74	--
39	6	26 Apr 74	0530
40	5	7 Jun 74	0430

(Continued)

* Source of data: Land Management Branch, DFAE, Fort Carson, Colorado.

(Sheet 1 of 3)

Table 7 (Continued)

Sighting No.	Number of Deer	Date of Sighting	Time of Sighting, hr
41	3	7 Jun 74	1800
42	2	13 Jun 74	2215
43	1	13 Jun 74	2330
44	2	20 Jun 74	2000
45	2	--	--
46	20-30	24 May 74	1130
47	1	25 May 74	2100
48	1	9 Jul 74	1835
49	7	8 Apr 74	2300
50	3	7 Apr 74	2030
51	1	22 Jul 74	0420
52	3	22 Jul 74	0320
53	2	11 Apr 74	2330
54	1	3 Jul 74	2100
55	1	10 Apr 74	1430
56	3	8 Apr 74	0830
57	6	20 May 74	--
58	1	1 Apr 74	0630
59	2	3 Mar 74	1600
60	5	1 Apr 74	0920
61	1	5 Apr 74	1100
62	1	6 Apr 74	0030
63	4	8 Mar 74	2030
64	2	3 Jul 74	2045
65	1	4 Aug 74	2135
66	1	2 Aug 74	1500
67	2	3 Aug 74	0530
68	2	3 Aug 74	0515
69	1	1 Aug 74	0730
70	2	1 Aug 74	2130
71	1	30 Jul 74	1930
72	3	1 Aug 74	1030
73	2	25 Aug 74	0755
74	1	27 Aug 74	0613
75	3	6 Sep 74	0630
76	2	20 Aug 74	0445
77	7	20 Aug 74	0500
78	1	20 Aug 74	2315
79	4	19 Sep 74	0430
80	3	8 May 75	2145

(Continued)

Table 7 (Concluded)

Sighting No.	Number of Deer	Date of Sighting	Time of Sighting, hr
81	7	10 May 75	2030
82	1	7 Jun 75	0600
83	2	18 May 75	1630
84	7	17 Jun 74	2015
85	3	29 May	2300
86	4	13 Sep 74	0200
87	5	13 Sep 74	--
88	6	24 Jun 75	0545
89	3	8 Sep 74	2000
90	2	26 Aug 74	0609
91	3	28 Aug 74	2050
92	3	26 Aug 74	1930
93	7	28 Aug 74	0730
94	6	25 Oct 74	0225
95	6	15 Nov 74	2030
96	4	30 Oct 74	1400
97	1	5 Dec 74	0100
98	1	2 Dec 74	1500
99	4	22 Dec 74	1930
100	1	2 Jan 75	1400
101	2	7 Jan 75	2015
102	1	7 Jan 75	1020
103	3	10 Feb 75	1800
104	1	28 Feb 75	0645
105	9	18 Mar 75	--
106	1	8 Apr 75	1815
107	3	17 Mar 75	0300
108	7	9 Mar 75	0915
109	7	8 Apr 74	2300

(Sheet 3 of 3)

Table 8

Data on Mule Deer Sightings for the Period May 1975-April 1976, Fort Carson, Colorado*

Sighting Location No.	Number of Deer	Date of Sighting	Time of Sighting, hr
1	4	7 May 75	0620
2	1	7 May 75	0710
3	3	8 May 75	2145
4	7	10 May 75	2030
5	2	18 May 75	1620
6	3	29 May 75	2300
7	1	7 Jun 75	0600
8	7	17 Jun 75	2015
9	6	24 Jun 75	0545
10	1	27 Jul 75	2200
11	1	28 Jul 75	2000
12	1	16 Aug 75	0830
13	1	22 Aug 75	0900
14	1	27 Aug 75	1530
15	5	30 Aug 75	2330
16	2	3 Sep 75	0500
17	2	8 Sep 75	0800
18	1	9 Sep 75	1015
19	1	11 Sep 75	0030
20	1	11 Sep 75	0300
21	3	11 Sep 75	2200
22	2	11 Sep 75	2330
23	1	12 Sep 75	0100
24	5	24 Sep 75	0930
25	2	27 Sep 75	0610
26	1	29 Sep 75	1030
27	4	11 Oct 75	0630
28	2	11 Oct 75	0700
29	1	14 Oct 75	0100
30	1	14 Oct 75	-
31	2	14 Oct 75	0400
32	1	15 Oct 75	0230
33	1	16 Oct 75	1400
34	4	18 Oct 75	1435
35	2	23 Oct 75	1100
36	2	30 Oct 75	0900

(Continued)

* Source of data: Land Management Branch, DFAE, Fort Carson, Colorado.

Table 8 (Concluded)

Sighting Location No.	Number of Deer	Date of Sighting	Time of Sighting, hr
37	6	4 Nov 75	0530
38	1	8 Nov 75	1530
39	2	11 Nov 75	2000
40	1	17 Nov 75	0500
41	1	5 Dec 75	0830
42	1	6 Dec 75	0630
43	1	6 Dec 75	0700
44	1	7 Dec 75	0922
45	3	7 Dec 75	1300
46	5	27 Dec 75	-
47	8	29 Dec 75	-
48	3	18 Jan 76	1000
49	4	23 Feb 76	1100
50	5	3 Mar 76	0830
51	7	7 Mar 76	1530
52	2	14 Mar 76	1200
53	3	16 Mar 76	2300
54	6	21 Mar 76	0015
55	9	30 Mar 76	1800
56	4	1 Apr 76	1830
57	3	5 Apr 76	0630
58	4	6 Apr 76	0240
59	2	6 Apr 76	0050
60	1	10 Apr 76	2300
61	3	11 Apr 76	1600
62	1	13 Apr 76	0515
63	8	15 Apr 76	1800
64	8	15 Apr 76	1815
65	1	15 Apr 76	2030
66	2	20 Apr 76	2200
67	2	22 Apr 76	0830
68	2	25 Apr 76	0200

Table 9

Descriptions of Vegetation at Deer Sighting Locations, Fort Carson, Colorado, October 1976

Sighting Location No.*	Description of Vegetation	Remarks
1	Mixed natural grasses and forbs 30-50 cm high	--
2	Pinyon pine, juniper, oak, and mountain mahogany 3-5 m high and spaced 3 m	--
3	Cottonwood, willow, and some juniper in clumps 2-16 m high and spaced 15-20 m	Adjacent to flowing stream
4	Mixed natural grasses and forbs 30 cm high with some scattered oak and soapweed 50-300 cm high	--
5	--	Not visited
6	Mixed natural grasses and forbs 30 cm high with some scattered oak and juniper 2-5 m high	--
7	Mixed natural grasses and forbs 30-50 cm high; adjacent western uplands with pinyon pine, mountain mahogany, juniper, and scattered oaks 3-5 m high and spaced 10-20 m	--
8	--	Not visited
9	--	Not visited
10	Oak, cottonwood, and willow 3-15 m high and spaced 10-15 m; some mixed grasses and forbs 30-120 cm high	Adjacent to flowing stream
11	Mixed natural grasses and forbs 30-50 cm high; adjacent slopes with pinyon pine, ponderosa pine, juniper, mountain mahogany, willow, and oak 2-10 m high and spaced 20 m	--

(Continued)

* See Figure 14 and Table 7

(Sheet 1 of 9)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
12	--	Not visited
13	Mixed natural grasses and forbs 30-50 cm high; adjacent western uplands with pinyon pine, mountain mahogany, juniper, and scattered oak 3-5 m high and spaced 10-20 m	--
14	--	Not visited
15	Mixed natural grasses and forbs 30-50 cm high	--
16	--	Not visited
17	--	Not visited
18	--	Not visited
19	Mixed natural grasses and forbs 20-40 cm high	--
20	--	Not visited
21	Mixed natural grasses and forbs 30-50 cm high with some scattered pine and juniper 2-3 m high	--
22	Ponderosa pine, pinyon pine, mountain mahogany, and juniper 3-10 m high and spaced 5 m	Many 30-cm-basal-diam trees, 70-80 years old, removed 10-15 years earlier; many deer signs including fresh tracks (parallel to ridge line), droppings, and places on pine and juniper trees where bucks had apparently rubbed their antlers; also cougar and coyote tracks

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
23	Ponderosa pine, oak, mountain mahogany, pinyon pine, juniper, and willow 2-10 m high and spaced 20-50 m; grasses 30-50 cm high	In a draw
24	Ponderosa pine, pinyon pine, oak, juniper, and mountain mahogany 3-15 m high and spaced 5-8 m	--
25	Oak, mountain mahogany, and some juniper 1-2 m high and spaced 5 m	In a draw
26	Same as No. 25	--
27	Mixed natural grasses and forbs 30-50 cm high with a few scattered juniper and pinyon pines 2-4 m high; adjacent uplands contain juniper, pinyon pine, mountain mahogany, and ponderosa pine 3-10 m high and spaced 5 m	-- --
28	--	Not visited
29	Ponderosa pine, pinyon pine, juniper, oak, and mountain mahogany 3-16 m high and spaced 25-30 m	--
30	Mountain mahogany, oak, and soapweed 0.7-1.5 m high and spaced 5 m	--
31	--	Not visited
32	--	Not visited
33	Pinyon pine, oak, mountain mahogany, and sparse nonwoody vegetation 2-4 m high and spaced 10-15 m	--
34	Juniper, pinyon pine, and a few oak 3-4 m high and spaced 20-25 m	--

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
35	Mixed natural grasses and forbs 30-50 cm high; adjacent eastern uplands with pinyon pine and juniper 2-4 m high and spaced 30-50 m	--
36	Mixed natural grasses and forbs 30-50 cm high	--
37	Same as No. 36	--
38	Mixed natural grasses and forbs 30-100 cm high	--
39	Same as No. 36	--
40	Mixed natural grasses and forbs 30-50 cm high; adjacent uplands with pinyon pine and juniper 1-3 m high and spaced 12-15 m	--
41	--	Not visited
42	--	Not visited
43	Mixed natural grasses and forbs 30-50 cm high and sparse; few scattered juniper, mountain mahogany, and pinyon pine 1-2 m high	--
44	Mixed natural grasses and forbs 20-30 cm high with ponderosa pine, pinyon pine, oak, and some cottonwood 2-12 m high and spaced 15-25 m	--
45	--	Not visited
46	--	Not visited
47	Cottonwood, willow, and some juniper in clumps 2-16 m high and spaced 15-20 m	Adjacent to flowing stream

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
48	Mixed natural grasses and forbs 30-50 cm high	--
49	--	Not visited
50	Mixed natural grasses and forbs 20-30 cm high with ponderosa pine, pinyon pine, oak, and some cottonwood 2-12 m high and spaced 15-25 m	--
51	--	Not visited
52	Mixed natural grasses and forbs 30-50 cm high with a few scattered pinyon pine and juniper 3-5 m high	--
53	Same as No. 50	
54	Mixed natural grasses and forbs 30-50 cm high with some scattered oak and soapweed 30 cm high	--
55	--	Not visited
56	Mixed natural grasses and forbs 20-30 cm high with ponderosa pine, oak, pinyon pine, juniper, and mountain mahogany 2-14 m high and spaced 20-50 m	In a draw
57	Mixed natural grasses and forbs 25-40 cm high	--
58	Mixed natural grasses and forbs 30-50 cm high with scattered oak and soapweed 30 cm high	--
59	Ponderosa pine, pinyon pine, juniper, some oak, and mountain mahogany 3-10 m high and spaced 10-15 m	--
60	Same as No. 50	--

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
61	Mixed natural grasses and forbs 30-50 cm high	--
62	Same as No. 61	--
63	Mixed natural grasses and forbs 25-40 cm high	--
64	Mixed natural grasses and forbs 20-70 cm high; to the east, a flowing creek with cottonwood, willow, and oak 3-12 m high and spaced 6 m	--
65	Cottonwood, willow, and some juniper in clumps 2-16 m high and spaced 15-20 m	Adjacent to flowing stream
66	Ponderosa pine, pinyon pine, oak, juniper, and mountain mahogany 3-15 m high and spaced 12 m	--
67	Same as No. 61	Many bare spots
68	Mixed natural grasses and forbs 50-100 cm high	--
69	Mixed natural grasses and forbs 20-40 cm high	--
70	--	Not visited
71	Oak, mountain mahogany, juniper, and ponderosa pine 2-10 m high and spaced 10 m	--
72	--	Not visited
73	Mixed natural grasses and forbs 30-70 cm high	--
74	Pinyon pine, oak, mountain mahogany, and sparse nonwoody vegetation 2-4 m high and spaced 10-15 m	--
75	Mixed natural grasses and forbs 30-50 cm high with scattered pinyon pine and juniper 2-4 m high	--

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
76	Mixed natural grasses and forbs 30-70 cm high with scattered juniper 3 m high and soapweed 50 cm high	Doe and fawn tracks in road leading to nearby stream
77	Oak and mountain mahogany 1-3 m high and spaced 1 m with some mixed grasses and forbs 30 cm high	--
78	--	Not visited
79		Not visited
80	Mixed natural grasses and forbs 25-40 cm high	--
81	Mixed natural grasses and forbs 50-100 cm high	--
82	--	Not visited
83	--	Not visited
84	Ponderosa pine, oak, mountain mahogany, pinyon pine, and juniper 2-10 m high and spaced 20-50 m with mixed grasses and forbs 30-50 cm high	--
85	Mixed natural grasses and forbs 50-100 cm high	--
86	--	Not visited
87	Mixed natural grasses and forbs 30-50 cm high, adjacent uplands with juniper 2-4 m high and spaced 5-10 m	--
88	Ponderosa pine, pinyon pine, juniper, and mountain mahogany 2-10 m high and spaced 15-20 m	--
89	Mixed natural grasses and forbs 30 cm high with scattered oak and juniper 2-5 m high	--

(Continued)

Table 9 (Continued)

Sighting Location No.	Description of Vegetation	Remarks
90	Mixed natural grasses and forbs 30-50 cm high	--
91	Cottonwood, willow, and some juniper in clumps 2-16 m high and spaced 15-20 m	Adjacent to flowing stream
92	--	Not visited
93	--	Not visited
94	Mixed natural grasses and forbs 20-40 cm high	--
95	--	Not visited
96	--	Not visited
97	Mixed natural grasses and forbs 30-50 cm high with scattered juniper and pinyon pine; adjacent slopes contain ponderosa pine, pinyon pine, juniper, mountain mahogany, and scattered oak 3-10 m high and spaced 5-7 m	--
98	--	Not visited
99	--	Not visited
100	Mixed natural grasses and forbs 30-50 cm high with some scattered juniper and pinyon pine 2-4 m high; adjacent slopes with pinyon pine and juniper 3-5 m high and spaced 8-15 m	--
101	--	Not visited
102	Mixed natural grasses and forbs 30-50 cm high with scattered juniper 2-4 m high and spaced 4 m	--

(Continued)

Table 9 (Concluded)

Sighting Location No.	Description of Vegetation	Remarks
103	--	Not visited
104	Nonwoody vegetation 30-70 m high with cottonwood, pinyon pine, ponderosa pine, juniper, willow, and mountain mahogany 3-15 m high and spaced 30-50 m; adjacent eastern slope with pinyon pine and juniper 3-5 m high and spaced 6-10 m	In a draw
105	Mixed natural grasses and forbs 20-30 cm high with ponderosa pine, pinyon pine, oak, and some cottonwood 2-12 m high and spaced 15-25 m	--
106	Mixed natural grasses and forbs 25-40 cm high	--
107	--	Not visited
108	Same as No. 105	
109	--	Not visited

(Sheet 9 of 9)

Table 10

Sighting Data on Selected Animal Species

at Fort Carson, Colorado*

Sighting Location No.	Number of Animals	Date of Sighting	Time of Sighting hr
	Scaled Quail (Callipepla squamata)		
1	10	19 Apr 75	1700
2	25	2 Jan 75	1830
3	25	11 Sep 74	1400
4	1	10 Aug 75	
5		10 Dec 74	
6		10 Dec 74	
7		10 Dec 74	
8		10 Dec 74	
9		10 Dec 74	
10	15	16 Dec 74	1600
11	30	26 Feb 75	1630
	Pronghorn (Antilocapra americana)		
12	15	22 Aug 74	0900
13	2	31 Aug 74	1640
14	10	11 Sep 74	1330
15	16	16 May 74	1230
16	2	17 Jul 74	1100
17	5	9 Aug 74	1930
18	1	18 May 75	1100
19	4	11 May 75	2000
20	3	31 Aug 74	1155
21	17	25 Dec 74	1050
	Porcupine (Erethizon dorsatum)		
22	1	16 Sep 74	012-
23	1	19 Sep 74	0230
24	1	23 Apr 75	0300
25	1	19 Apr 74	0325
26	1	8 May 74	0130
27	1	25 May 74	2200
28	1	27 Aug 74	0720
29	1	21 May 75	0300
30	1	21 Dec 74	0200

(Continued)

* Source of Data: Land Management Branch, DFAE, Fort Carson, Colo.

Table 10 (Concluded)

Sighting Location No.	Number of Animals	Date of Sighting	Time of Sighting hr
	Black Bear (Ursus americanus)		
31	1	22 Aug 74	2210
32	1	24 Jun 74	1100
33	1	17 May 74	1200
34	1	15 Sep 74	1540
35	1	29 Jun 75	2300
36	1	5 Mar 75	1700
	Bobcat (Lynx rufus)		
37	1	29 Apr 74	0230
38	1	2 Jun 74	
39	1	2 Apr 74	0145
40	1	25 Aug 74	0920
	Bald Eagle (Haliaeetus leucecephalus)		
41	1	13 Oct 74	0830
42	2	14 Mar 75	1220
	Golden Eagle (Aquila chrysaetos)		
43	1	28 Sep 74	1730
44	1	29 May 75	1030
	Mountain Lion (Felis concolor)		
45	1	---	--
46	1	16 Mar 75	1535

APPENDIX A: DEFINITIONS OF ANIMAL DATA INFORMATION CATEGORIES

FAMILY: The taxonomic group into which the related genera of organisms are divided. Scientific (Latin) family names are those used by most zoologists; animal family names end in "idae." Vernacular or common names are those used by the general public and may vary with locality.

SPECIES: A term that refers to both the scientific name and common name of a group of organisms.

Scientific Name: A taxonomic term applied by zoologists to a group of organisms that share a common gene pool and that are reproductively isolated from all other such groups (biological species) or applied to groups of organisms within a biological species that are partly isolated reproductively (subspecies).

Common Name: A term applied by the general public to biological species or subspecies.

LEGAL STATUS: A taxon's position in relation to state or Federal laws relating to its protection or management, as follows:

Not Yet Nominated: No person or organization has suggested that the taxon be considered for special protection under law.

Nominated and Rejected: The taxon has been proposed for consideration, has been evaluated with respect to population densities and geographic distribution or other criteria, and has been judged unneedful of special protective management under law.

Candidate, Status Undetermined: The taxon has been proposed for consideration (nominated) but has not yet been evaluated and judged with respect to need for special protective management under law (equivalent to "status undetermined" in alternative systems of classification).

Recommended: The taxon has been evaluated by the authorized reviewing committee or agency and has been judged, according to the established criteria, to be in need of special protective management or rehabilitation benefits under law. This may result in passive protective measures within the routine activities of the responsible management agency, such as

lifting of bounties or closed hunting seasons, but it only recommends and does not establish eligibility for special welfare benefits under the Federal Endangered Species Conservation Act or the state or local equivalent thereof.

Beneficiary: The taxon is listed in the Federal Register or the state or local equivalent thereof and is therefore eligible for special welfare benefits under the Federal Endangered Species Conservation Act or the state or local equivalent. (In states without endangered wildlife conservation laws, no taxa can be consigned to this category with respect to the state, even though in most such states there are at least several taxa that would be placed in this category immediately upon enactment of such laws.)

Extirpated: There are thought to be no living representatives of the taxon currently resident within the geographic unit under consideration, not routinely migrating through it, where once there were. (By dictionary definition, "extirpated" is synonymous with "extinct"; but by convention in this information system, "extirpated" refers to extinction with respect to a given geographic boundary; whereas "extinct" is used when there are thought to be no living representatives of the taxon remaining anywhere in the world. Extinct taxa are by definition extirpated from the geographic unit under consideration.)

Information not Available: The information on legal status is unknown; not to be confused with "Candidate, Status Undetermined."

VALUE POTENTIAL, POSITIVE: The beneficial aspects of a taxon to man or to other members of the taxon's biotic community.

Recreational: The taxon enhances recreational areas or provides tourist attractions.

Commercial: The taxon's presence or utilization results in financial gain.

Scientific: The taxon is valuable as a subject for research.

Aesthetic: The taxon has appeal and beauty.

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2 of 4

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Ecological: The taxon is an important associate in the biotic community as a food species, predator species, etc.

Legal Protection: The taxon is valuable because it is rare and in danger of extinction with concurrent loss of its gene pool.

VALUE POTENTIAL, NEGATIVE: The detrimental aspects of a species to man, man's property, or to other members of the taxon's biotic community.

Recreational: The taxon causes damage or detrimental effects to recreational use of an area.

Commercial: The taxon may cause loss of the financial value of an area by its presence.

Scientific: The taxon may serve as a vector for various diseases and parasites.

Aesthetic: The taxon may be aesthetically disgusting.

Ecological: The taxon's presence may disrupt ecological community balances.

Legal Protection: The taxon may be legally defined as an outlaw or pest.

DESCRIPTION: Information about a taxon that enables one to form a mental image of the taxon, as follows:

Documents with Illustrations: Texts that picture the taxon.

Physical Appearance: A brief general statement about visible physical attributes.

Field Marks or Distinguishing Characteristics: A brief summation of obvious markings or characteristics that distinguish the taxon from others of its general kind.

Critical Taxonomic Criteria: Distinguishing physical characteristics that differentiate similar taxa, especially when the taxonomy is confused and taxonomic differences are subtle.

RANGE: A geographic term identifying the general region within which the taxon is known to reside or migrate.

Locations or Regions: The physiographic provinces and areas that circumscribe the range or the boundaries of the range.

Counties: The designated political divisions of a state for all states except Louisiana, which is divided into parishes.

Ownership/Responsibility: Criterion under whose jurisdiction the range area falls (Federal, state, county, etc.).

HABITAT: An environmental concept specifying a particular combination of environmental conditions that attract a taxon to a particular area and provide the amenities necessary for it to perform its essential life functions.

Plant-Animal Community: An integrated, mutually adjusted assemblage of plants and animals (biota) inhabiting an area considered to be in a state of dynamic equilibrium.

Critical Habitat: A crucial area that possesses minimum requirements or special attributes that are required by a taxon due to its specialized adaptations or behavior patterns.

FOOD HABITS: Primary food, search and capture techniques, consumption and storage habits, consumption rates, or other characteristics of a taxon that relate to its food requirements and feeding behavior.

SHELTER REQUIREMENTS: Those attributes of the habitat that a taxon uses for protection from adverse environmental conditions, for roosting or sleeping places, and for protection from predators.

Site Preferences: The areas within its habitat in which a taxon prefers to roost, sleep, or take shelter.

Materials: The materials used to construct shelters or sleeping quarters.

NESTING AND BEDDING REQUIREMENTS: Those attributes of a habitat that a taxon used for nests and brood beds; they may be, but are not always, more specialized than the needs for routine shelter.

Site Preferences: The areas within its habitat wherein a taxon constructs nests or beds.

Materials: Materials used in construction nests and beds.

RITUAL REQUIREMENTS: Specialized behavior patterns, especially those that are essential for establishing social order (dominance), for maintaining spatial structure in the population (territories), or for inducing reproductive activities (courtship). In addition to essential social rituals, some taxa engage in individual specialized behavior that, though not essential to maintenance of the population, does

contribute markedly to the general health and well-being of the taxa. A habitat that offers opportunities for the taxa to engage in these individualized rituals will be more attractive and will support a more active population than will habitats that lack such amenities.

Site Preferences: Specific areas used for essential social and other individualized rituals.

Materials: Objects used by taxon in individualized and social rituals.

POPULATION STRUCTURE AND TRENDS: The total number of individuals known or thought to be in existence is reported, and the regional or local population densities and apparent trends are noted based on sighting records, censuses, etc. For these data, the degree of certainty is indicated when known. Notice is given as to whether the data were obtained by direct head count or estimate, when, and by whom. The regional and local population age and sex structures are necessary to extrapolate populations trends and are reported when known. The social structure of the population is described, with special attention to established interactions between individuals that may limit population densities, such as territoriality, gregariousness, and pecking orders. Characteristics of behavior that might suggest ways to manipulate or manage the environment to benefit the population are identified.

REPRODUCTION AND SURVIVAL: Propagation of offspring and survival rate of offspring may be considered synonymous with breeding and breeding success. Includes five aspects of species' breeding characteristics.

Phenology: A description of the time of appearance of characteristic periodic events in the life cycles of a taxon under natural conditions, especially those events influenced by temperature, latitude, and altitude.

Mating Habits: Characteristic rituals and activities associated with courtship and breeding.

Family Structure: Male:female ratio in a family unit and the number of offspring per litter, or the number of eggs per clutch, produced by the female(s) of the family. Includes a description of the social structure of the family.

Survival Rates: Number of offspring surviving to reproductive maturity in comparison to the number of offspring produced in a given time period.

Longevity: Length of a taxon's life under natural conditions may be divided into physiological and ecological factors, the former representing the capacities of an individual of a species to live out its life span, and the latter depicting observed life durations of the members of a population.

BIBLIOGRAPHY: All references cited in the preceding information fields are listed, including the document used as an authority for the name of a taxon and any other authoritative sources of information relating in whole or in part to the preservation, conservation, management, or ecology of the taxon. General references, such as textbooks or articles on wildlife management in general, are not normally included.

APPENDIX B: NARRATIVE FOR THE MULE DEER

FAMILY:

Scientific: Cervidae (Jones et al. 1975)

Common: Cervids

SPECIES:

Scientific: Odocoileus hemionus (Jones et al. 1975)

Common: Mule deer

LEGAL STATUS:

The mule deer is protected by state game laws in Arizona, California, Colorado, Idaho, Kansas, Minnesota, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming, and by provincial game laws in Alberta, British Columbia, and Saskatchewan (Barnes et al. 1970). Better enforcement of beneficiary game laws and the provision of suitable refuges and winter range should enable the mule deer to be managed to any desired number in the western mountainous ranges (Bailey 1931).

VALUE POTENTIAL, POSITIVE:

Recreational: The mule deer is the most important big game animal of our western states. It serves as a valuable food source and is kept in control by coyotes, cougars, and bears, as well as by sportsmen (Palmer and Fowler 1975). In mountainous resort areas, mule deer herds are a major tourist attraction.

Scientific: Grizzly bears (Ursus arctos horribilis), a Federally protected species, depend on mule deer fawns as a predominant food source during fawning seasons. Grizzlies may take old and sick adult deer on occasions (Cahalane 1961, Federal Register 1975).

Ecological: A number of large predators depend on the mule deer as a major food source. Western cougars feed chiefly on deer; consequently, their ranges often coincide with the habitat of the mule deer. Mountain lions have been accredited with killing one deer per week (Hamilton 1939). Bears often prey on mule deer fawns and diseased or crippled adults. Coyotes

usually tend to take only the crippled, diseased, or young mule deer. Other predators, such as wolverines, lynxes, bobcats, and golden eagles, take a few deer, usually during deep snows and during times of food scarcity (Cahalane 1961).

VALUE POTENTIAL, NEGATIVE:

Commercial: When mule deer numbers are not controlled, damage to orchard and field crops may result (Palmer and Fowler 1975). Increased numbers of deer may lead to competition with domestic livestock for food, especially in the late summer when both cattle and mule deer use sagebrush vegetation (Dusek 1975).

Scientific: In 1924, epizootic foot and mouth disease was harbored in mule deer herds in California (Dixon 1934).

Ecological: When mule deer overrun an area, damage and overgrazing of the range and forests may result (Palmer and Fowler 1975). Overgrazing by mule deer reduces food supplies for other herbivores of the area, such as pronghorns, buffalo, elk, and other deer species.

DESCRIPTION:

Documents with Illustrations: "The Mammals of North America" (Hall and Kelson 1959), "Mammals of North America" (Cahalane 1961), "American Mammals" (Hamilton 1939).

Physical Appearance: "A rather stout-bodied deer. Antler tines of the male are usually pronged or branched. In summer, the body, neck, and upper legs are pale, dull-yellowish brown to yellowish tawny; upper-throat, inner ear, and inside of legs whitish; forehead dark-dark brown, a large patch of white on the rump; tail white with a black tip; belly dark brownish to blackish. In winter, the color is dark gray instead of brownish. Size variable with locality: total length, 56 to 68 inches; height at shoulder 36 to 42 inches; weight 145 to 200 pounds up to 400 pounds as an extreme" (Cahalane 1961).

Field Marks: Ears large and broad. Antler tines branched instead of single like the whitetails. Tail whitish and rounded with

black tip instead of all black on the outer surface (black-tailed deer) or brushy and completely white beneath (white-tailed deer) (Cahalane 1961).

Critical Taxonomic Criteria: "Dark brown patch extending nearly to eyes on forehead; brown patch on each side of nose. Ears black on front border...tail black tipped...Antlers with short subbasal snag, beam curving outwards and upwards, forking dichotomously, the prongs about equal size" (Hall and Kelson 1959). "Glandular area on upper part of metatarsus about 4 or 5 inches long" (Bailey 1931).

RANGE:

The mule deer ranges throughout the western United States and southwestern Canada, from western Minnesota to north-central Alberta and eastern British Columbia, and south through eastern Colorado and western Texas to the Tropic of Cancer in Mexico; west to central Washington, Oregon, and the Pacific Coast south of San Francisco Bay (Cahalane 1961).

HABITAT:

Climate: As noted by diversity and extent of habitat, the mule deer may flourish in various climatic conditions. In the western United States, the climate is characterized by cold winters and warm spring and summer months. In July, normal daily temperature maximums reach 85°F in the north to 100°F in the south. Normal daily minimums in January range from -5°F in the north to 10°F in the south. Precipitation ranges from 16 in. on the eastern range to 100 in. on the western coastal zones. The northern range area exhibits a mean annual total precipitation of 32 in.; the southern edge, 16 in. In some areas of the Rocky Mountains, mean annual total precipitation may reach 32 in. Mean annual total snowfall varies from 1 in. in the southern range to over 200 in. in the northernmost range. Most of the annual precipitation of the western United States occurs between September and April. Mean daily relative humidity ranges from 40 percent in the

south to 70 percent in the north. Mean annual pan evaporation varies from over 100 in. in the south to 25 in. in the north. Wind currents vary in speed and direction, with extreme wind speeds and turbulence occurring during tornadoes or chinooks. Mean daily solar radiation is 700 Langleys in the southern range to 650 Langleys in the north. Normal annual sea level pressure ranges from 1014 millibars (mb) in the southeastern range to 1016 mb in the extreme southwestern and northeastern portions of the mule deer range (the previous climatic data was abstracted from Baldwin 1973). Dorrance (1966) reported observations by several authors (Anderson 1959, Bailey 1960, Buss and Harbert 1950, Cowan 1956a, Loveless 1964), concerning the effects of climatic conditions on mule deer. Loveless (1964) observed that Colorado mule deer sought shelter when temperatures were 15°F and lower and wind velocity exceeded 25 mph. Bailey (1960) found that wind had little effect on feeding; however, during strong winds, beds were located in dense shrub cover. Cowan (1956a) reported that deer took cover on the first day of moderately heavy rains, but on the second consecutive day, they began feeding. Rain apparently had little or no effect on mule deer on Montana winter ranges (Bailey 1960). Loveless (1964) indicated that snow depth was one of the major factors influencing deer activity. Locations frequently used by deer on south- and east-facing shrub types and open timber shrub-understory types had less surface snows than other exposed areas. Dusek (1975) stated that Loveless (1964) and Gilbert et al. (1970) found that snow depths of 0.5-0.6 and 0.46 m, respectively, prevented extensive use of an area by mule deer.

In western Oregon, sudden heavy snowstorms cause deer to move into canyons and then into brush or timber stands (Dorrance 1966). Loveless (1964) suggests that deer may respond to sudden changes of temperature, moving accordingly on their

winter range to maintain a "comfortable" temperature (15°-45°F). According to Dorrance (1966), Linsdale and Tomich (1953) noted that deer took cover in shade when air temperatures exceeded 80°F. Anderson (1959) found that nocturnal activity was highest following days with maximum high temperatures; Loveless (1964) indicated that nocturnal activity was low during cold periods. Periods of high temperatures and low humidity reduce deer activity, with low temperature and high humidity increasing their activity. Low temperature (less than 25°F) and low humidity (less than 20 percent) were reported to cause a decrease in deer activity (Loveless 1964). Observations by Dixon (1934) regarding effects of light on mule deer indicated avoidance of direct sunlight on warm days (45°F and above) (Loveless 1964) and contact with sunlight on cold days (0°F and below) (Loveless 1964). Buss and Harbert (1950) and Anderson (1959) observed that deer activity was greater on moonlit nights than on darker nights.

Topography: The range of the mule deer includes the following physiographic provinces in western North America: Great Plains, Southern Rocky Mountains, Middle Rocky Mountains, Northern Rocky Mountains, Wyoming Basin, Colorado Plateaus, the Basin and Range Province, Central Lowland, Cascade-Sierra Mountains, and Pacific Border (Fenneman 1931). Fenneman (1931) states that elevations range from below sea level (Death Valley) to greater than 14,000 ft (Rocky and Cascade Mountain ranges); relief varies from "low" to strong (i.e. local relief ranges from 0 to 1000 ft). The mule deer prefers mountainous foothill country, open plains, and brush or woods but generally avoids heavy woodlands (Hall and Kelson 1959, Lovaas 1958, Martin et al. 1951). The deer uses foothill slopes in all seasons, preferring sides of protective gullies in the winter months (Dusek 1975). Hall and Kelson (1959) state that the bounding gait of this deer seems well suited to rough terrain.

Natural Vegetation: Natural vegetation within the mule deer range comprises a variety of vegetative zones. Kuchler (1965) mapped the potential natural vegetation areas of the United States, indicating that the following predominant vegetation types are within the eastern mule deer range (from north to south):

Buffalo grass	(<u>Buchloe dactifoides</u>)
Western wheatgrass	(<u>Agropyron smithii</u>)
Big bluestem	(<u>Andropogon gerardi</u>)
Needlegrass	(<u>Stipa spartea</u>)
Blue grama	(<u>Bouteloua gracilis</u>)
Needle-and-thread grass	(<u>Stipa comata</u>)
Green needlegrass	(<u>Stipa viridula</u>)
Sand bluestem	(<u>Andropogon halli</u>)
Little bluestem	(<u>Andropogon scoparius</u>)
Sand sage	(<u>Artemisia filifolia</u>)
Hairy grama	(<u>Bouteloua hirsuta</u>)
Galleta	(<u>Hilaria jamesii</u>)
Tarbush	(<u>Flourensia cernu</u>)
Juniper	(<u>Juniperus</u> spp.)
Oak	(<u>Quercus</u> spp.)
Creosote bush	(<u>Larrea divaricata</u>)

The dominant vegetation in the central portion of the range comprises (from north to south):

Ponderosa pine	(<u>Pinus ponderosa</u>)
Idaho fescue	(<u>Festuca idahoensis</u>)
Douglas fir	(<u>Pseudotsuga menziesii</u>)
Subalpine pine	(<u>Alrie lasiocarpa</u>)
Engelmann spruce	(<u>Picea engelmanni</u>)
Tobosa	(<u>Hilaris mutica</u>)
Bristlecone pine	(<u>Pinus aristata</u>)
Limber pine	(<u>Pinus flexilis</u>)
Juniper	(<u>Juniperus</u> spp.)
Pinyon pine	(<u>Pinus edulis</u>)

One leaf pine	(*Pinus monophylla*)
Mountain mahogany	(*Cercocarpus ledifolius*)
Gambel oak	(*Quercus gambeli*)
Big sagebrush	(*Artemisia tridentata*)
Shad scale	(*Atriplex confertifolia*)
Greasewood	(*Sarcobatus vermiculatus*)
Galleta	(*Hilaria jamesii*)
Blue grama	(*Bouteloua gracilis*)
Blue spruce	(*Picea pungens*)
White fir	(*Abies concolor*)
Bentgrass	(*Agrostis* spp.)
Sedges	(*Carex* spp.)
Blue grass	(*Poa* spp.)

Predominant coastal and western vegetation include (from north to south):

Subalpine fir	(*Abies lasiocarpa*)
Engelmann spruce	(*Picea engelmanni*)
Sitka spruce	(*Picea sitchensis*)
Western red cedar	(*Thuja plicata*)
Western hemlock	(*Tsuga heterophylla*)
Douglas fir	(*Pseudotsuga menziesii*)
Pacific silver fir	(*Abies amabilis*)
Ponderosa pine	(*Pinus ponderosa*)
White fir	(*Abies concolor*)
Incense cedar	(*Librocedrus decurrens*)
Sugar pine	(*Pinus lambertiana*)
Madrone	(*Arbutus menziesii*)
Live oak	(*Quercus* spp.)
Laurel	(*Umbelluria* spp.)
Needlegrass and spear grass	(*Stipa* spp.)
Sagebrush	(*Artemisia* spp.)
Creosote bush	(*Larrea divaricata*)
White bur sage	(*Franseria dumosa*)
Tarbush	(*Flourensia cernua*)

Prickly pear (*Opuntia* spp.)

Palo verde (*Circidium microphyllum*)

Corresponding map (Kuchler 1964) numbers for vegetation types for the eastern range are 67, 66, 65, 70, 23, 59, and 31; for the central range portion, 11, 12, 15, 55, 22, 23, 37, 38, 40, 53, 20, and 52; and for the western-coastal area, 15, 1, 2, 3, 10, 5, 29, 48, 38, 41, 42, 43, and 44.

Mule deer concentration within specific vegetation zones is highly dependent on seasonal migration patterns (Russell 1932). In a study of central and western mountains of Montana, Dusek (1975) defined three typical vegetation zones in which mule deer exist: grassland (grasses, deciduous shrubs, and junipers), big sagebrush (sages, deciduous shrubs, forbs, and wheatgrasses), and silver sagebrush (sages, wheatgrasses, and cottonwoods). Grassland-type vegetation occurs mainly on tablelands above large drainage areas and inside coulees. Dusek noted that 43 percent of the observations during summer months were close to drainage areas, indicating grassland site selectivity. According to Dusek (1975), Kamps (1969) also found greater usage by mule deer of this type of vegetation as compared to other types during summer months in the Snowy Mountains. During winter, 48 percent of the mule deer were observed on grassland vegetation types. Lovaas (1958) observed that grasslands were the major winter range of the mule deer in Little Belt Mountains, Montana.

Big sagebrush vegetation occurs on gentle to steep slopes adjacent to floodplains of major drainages and in lower portions of some side coulees. During summer months, 38 percent of observed deer were on this type; during winter, 51 percent of observed deer were here. Silver sagebrush types are on major drainage floodplains, extending into the bottom of some side coulees. The silver sagebrush type accounted for only 19 percent of the seasonal mule deer observations,

mule deer being rare in this area during winter months (Dusek 1975). In the Judith River area, Lovaas (1958) classified vegetation zones according to elevations: spruce type (above 7000 ft) characterized by Engelmann spruce and alpine fir, lodgepole pine type (6000-7000 ft) with equal amounts of lodgepole pine and Douglas fir, ponderosa pine type (5000-6000 ft) comprised of ponderosa pine and Douglas fir, and prairie type (5000 ft and below) characterized by open grasslands interspersed with stands of ponderosa and timber pines. Bucks were found to some extent in all types (Lovaas 1958). Roughton (1963) classified two broad vegetative types in Cache la Poudre, Colorado: coniferous forests (6000-8000 ft above sea level on northern slopes), and mountain shrub range (6000 ft above sea level on southern slopes). Dominant conifers were ponderosa pine and Douglas fir with spruce-fir species interspersing at above 8000 ft (Roughton 1963, Dietz et al. 1962). Predominant shrubs occurring as high as 7800 ft included mountain mahogany, bitterbrush, and big sagebrush. Other significant vegetative zones included aspen-cottonwood draws (Populus spp.) and meadows at lower elevations of 6000 ft (Roughton 1963).

Animal Associates: An abundant fauna occurs within the range of the mule deer. Major herbivores are American buffalo (Bison bison), white-tailed deer (Odocoileus virginianus), elk (Cervis canadensis), pronghorn antelope (Antilocapra americana), hares (Lepus spp.), cottontails (Sylvilagus nuttallii), and domestic cattle, sheep, and horses (Russell 1932, Dusek 1975, Richens 1967, Cahalane 1961). Of these herbivores, other deer species may be the most numerous; bighorn and moose are scarce; and pronghorn antelope, though widely distributed, are not abundant. Although the lagomorphs (rabbits) are plentiful throughout the range, their influence on deer population has not been determined (Richens 1967). Domestic cattle may compete for similar forage types during

early summer months when forbs, such as yellow sweet clover, constitute important items in the diets of both (Dusek 1975). Dusek reports that in overgrazed areas, deer and cattle increase their use of deciduous browse species in late summer and early fall. Domestic sheep in Utah are highly competitive with deer since they prefer many of the same plant species and are efficient in using rough terrain (Richens 1967).

Major predators within the mule deer range include black bears (*Ursus americana*), grizzly bears (*Ursus horribilis*), cougars (*Felis concolor*), coyotes (*Canis latrans*), bobcats (*Felis rufus*), lynxes (*Felis lynx*), red foxes (*Vulpes fulva*), wolverines (*Gulco luscus*), and domestic dogs (Richens 1967, Cahalane 1961). Bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), turkey vultures (*Cathartes aura*), hawks (*Buteo* spp.), and falcons (*Falco* spp.) are among the most common raptors within the mule deer range (Richens 1967).

Mule deer are susceptible to most parasites and diseases that affect the white-tailed deer. The California foot and mouth disease epidemic of 1924-1925 took a toll of many thousands of mule deer. Also, modoc deer disease, which is caused by infection of mouth wounds or injuries by an organism known as *Actinomyces necrophorus*, was cited in California in 1924. Internal parasites, such as lungworms, tapeworms, eyeworms, and intestinal roundworms, may cause considerable loss of deer under adverse climatic conditions and food scarcity. However, under ordinary conditions when deer are in good physical condition and widely distributed over the entire range, losses due to these sources are few. External parasites are the indirect causes of serious losses among mule deer. Deer botflies (*Cephonomia pratti*), wood ticks (*Dermacentor occidentalis*), and deer tick flies (*Lipoptena depressa* and

L. subulata) are pests that tend to reduce vitality and disease resistance in mule deer (Dixon 1934).

FOOD HABITS:

Mule deer browse more than they graze, foraging primarily on shrubs and trees (Hamilton 1939). Mule deer also take forbs, grass/grass-like components, nuts, mosses, lichens, mistletoe, and fungi, with the last three items constituting major food items in the south-western range (Cahalane 1961, Martin et al. 1951). Water is obtained from eating snow and succulent plants (Dorrance 1966, Palmer and Fowler 1975). Mule deer do not paw through snow vigorously; therefore, they usually winter on wind-swept slopes. Dusek (1975) stated that activity of mule deer herds is related to feeding. He reported that during summer 74 percent of the daily observations of mule deer feeding were made from 1400 to 1600 hr, as compared to 20 percent after 0930 and 1130 hr. Dorrance (1966) reports that Swank (1958) observed deer feeding at all hours of the day during winter months, although they were more active in the early morning and late evening. Dusek (1975) observed that winter months were not characterized by peaks of feeding activity; 77 percent of the feeding observations were made between 0930 and 1130 hr. According to Dorrance (1966), Bailey (1960) found that mule deer on a Montana winter range feed between 0930 and 1130 hr and 1400 and 1600 hr. Cowan (1956) observed deer to prefer hillsides to flat areas, browsing on the margins of shrubs and avoiding thorny plants. McCulloch (1972) reports that some plants in Arizona seem distinctly unpalatable to deer. Turpentine bush (Alopappus laricifoluis), brittle bush (Encilia farinosa), and snakeweed (Gutierrezia sarothrae), which were abundant on the study area, were minor items in stomach samples. Browse portions of catclaw (Acacia greggii) and mesquite (Prosopis spp.) were scarce in the stomachs, but their fruits were found in appreciable quantities. According to Dorrance (1966), Cowan (1956) stated that mule deer avoided the seed heads of most grasses. Food studies have been conducted by various authors (Dixon 1934, Dusek 1975, Hamilton 1939, Kufeld et al. 1973,

Lovaas 1958, Martin et al. 1951, McCulloch 1972, Russell 1932) by means of rumen analysis and feeding site examination. Each food survey indicated mule deer to exhibit seasonal preference for the vegetation types eaten.

Common Name	Scientific	Season*	References**
	Browse Species - Trees and Shrubs		
Snowberry	Symphoricarpus spp.	SuF	1,2,4,6,8
Bitterbrush	Purshia tridentata	SuFW	1,4,6,8
Deer brush	Ceanothus integerrinus	FW	1,5,6,8
Pine	Pinus spp.	FWSpSu	1,2,6,8
Barberry, creeping (Oregon grape)	Berberis repens	WSu	1,2,6,8
Serviceberry	Amelanchier spp.	SuF	1,6,8
Sagebrush	Artemisia spp.	FWSp	1,2,4,6,8
Bearberry	Arctostaphylos uva-ursi	FW	1,2,6,8
Juniper	Juniperus spp.	WSp	1,2,4,6,8
Oak	Quercus spp.	FWSpSu	1,4,5,6,7,8
Mountain mahogany	Cercocarpus spp.	FWSpSu	1,3,5,6,8
Cliff rose	Cowania spp.	FW	1,5,6,8
Cedar	Juniperus spp.	FW	1,6,8
Rabbit brush	Chrysothamnus nauseosus	FW	1,4,6,8
Manzanita	Arctostaphylos spp.	FWSp	1,6,8
Cherry, wild	Prunus spp.	SuF	1,6,8
Poplar (including aspen and cottonwood)	Populus spp.	SuF	1,4,6,8
Fir, Douglas	Pseudotsuga taxifolia	WSpSu	1,2,3,4,6,8
Elderberry	Sambuscus melanocarpa	Su	1,3,6,8
Thimbleberry (black berries, raspberries)	Rubus spp.	Su	1,3,6

(Continued)

* Season abbreviations: F = fall; W = winter; Sp = spring; and Su = summer.

** Reference codes: 1 = Martin et al. 1951; 2 = Lovaas 1958; 3 = Russell 1932; 4 = Dusek 1975; 5 = McCulloch 1972; 6 = Dixon 1934; 7 = Hamilton 1939; and 8 = Kufeld et al. 1973.

Common Name	Scientific	Season	References
	Browse Species - Trees and Shrubs (Continued)		
Dogwood	Cornus spp.	FWSpSu	1,3,4,6,8
Rose, wild	Rosa spp.	FWSu	1,2,4,6,8
Willow	Salix spp.	SuF	1,3,6,8
Ash	Fraxinus pennsylvania		1,6,8
Kinnikinick	Arctostaphylos spp.	WSp	2,8
Chokecherry	Prunus virginiana	WSu	1,2,6,8
Mountain lover	Pachystima spp.	F	1,6
Buffalo berry	Shepherdia canadensis	SuFW	2,3,4,8
Barberry	Berberis spp.	FW	1,6,8
Fenderbush	Fenderlera spp.	W	1,6,8
Skunkbush sumac	Rhus trilobata	SuFW	1,4,6,8
Gooseberries	Grossularia inermis	Su	1,6,8
Currant bushes	Ribes aureum	Su	1,4,6,8
Paintbrush	Castilleja spp.	F	1,5,6,8
Calliandra	Calliandra eriophylla	SpSuF	5,8
	Forb and Herb Species		
Sunflower	Helianthus spp.	Su	1,6,8
Spanish clover	Lotus americanus	Su	1,6,7,8
Curly dock	Rumex crispus	Su	1,6,8
Buckwheat	Eriogonum spp.	SuFW	1,2,4,5,6,8
Lupine	Lupinus spp.	Su	1,5,6,8
Deer vetch	Lotus spp.	SpSu	1,5,6,8
Evening primrose	Oenethera spp.	Su	
Pigweed	Chenopodium album	Su	3,8
Dandelion	Taraxacum officinale	Su	2,3,8
Clover	Trifolium spp.	Su	1,3,4,8
Lomatium	Lomatium spp.	Sp	4,8
Knotweed	Polygonum spp.	Su	1,6,8
Asters	Aster spp.	SpFW	2,8
Cinquefoil	Potentilla fructosa	SpSu	2,3,8

(Continued)

Common Name	Scientific	Season	References
Forb and Herb Species (Continued)			
Geranium	*Geranium* spp.	SpSu	2,3,8
Alfalfa	*Medicago sativa*	SuW	1,4,6,8
Yellow sweet clover	*Melilotus officinalis*	Su	1,4,6,8
Twinflower	*Linnaea* spp.	SuW	2,8
Raceme pussytoes	*Antennaria racemosa*	FWSu	1,2,6
Daisies	*Erigeron* spp.	Su	2,8
Balsamroot	*Balsamorhiza sagittata*	F	2,8
Hoods phlox	*Phlox* spp.	WSpSuF	2,8
Prairie smoke	*Geum triflorum*	Sp	2,8
Soapweed, Yucca	*Yucca* spp.	W	2,4,8
Western yarrow	*Achillea millefolium*	FWSuSp	8
Small sagebrushes	*Artemisia* spp.	FWSp	1,2,4,6,8
Milk vetch	*Astralagus* spp.	Su	8
Bull thistle	*Cirsium* spp.	FWSuSp	8
Wild lettuce	*Lactuca* spp.	Su	8
Penstemon	*Penstemon* spp.	FWSuSp	8
Grama grass	*Bouteloua* spp.	SuF	1,5,6,8
Sedges	*Carex* spp.	FWSpSu	1,6,8
Oats, wild	*Arena fatua* and *barbata*	WSp	1,6,8
Fescue grass	*Festuca* spp.	FWSpSu	1,3,6,7,8
Bluegrass	*Poa* spp.	FWSpSu	1,3,6,7,8
Bromegrass	*Bromus* spp.	FWSpSu	1,3,5,8
June grass	*Koeleria cristata*	SpSu	1,3,6,8
Needlegrass	*Stipa* spp.	SpSuF	1,3,6,8
Wheatgrass	*Agropyron* spp.	SpSuF	1,3,6,8
Ricegrass	*Oryzopsis* spp.	SpSuF	1,6,8

Spring Foods (March, April, May): Dusek (1975) reports that browse plants make up 59 percent of the spring diet, with *Juniper* spp. being the most predominant item from March to April.

Forbs and grasses were found to constitute 24 and 17 percent, respectively, of the season's diet. Lomatium spp. was the most important forb, and grasses were more abundant in spring samples. Dixon (1934) cited that California mule deer forage on fresh green grasses whenever they are available. In May 1929, he observed California mule deer in Yosemite National Park feeding predominantly on Kentucky blue grass and meadow fescue, these two forms together constituting 40 percent of the spring diet. Mule deer rumen analyses indicated that on the chaparral and semidesert brushlands of southern Arizona, forbs and calliandra browse were major types taken in late spring, approximately 25 and 27 percent, respectively (McCulloch 1972). Lovaas (1958) indicated that in April and May, juniper-kinnikinick fir browse represented 41.5 percent of items found in rumen samples, fresh green grasses constituted 27.5 percent, and forbs, mainly dandelion and prairie smoke, made up 20.6 percent. Kufeld et al. (1973) found that in the Rocky Mountains, average consumption of trees and shrubs was 49 percent; forb and grasslike components averaged 25 and 26 percent, respectively. Use of grasses, sedges, and rushes were highest during spring. In Colorado, consumption of trees and shrubs ranged from 58 to 92 percent; forbs, from 0 to 9 percent; and grasslike components, from 4 to 42 percent.

Summer Foods (June, July, August): Lovaas (1958) found that on the summer range of Little Belt Mountains, Montana, forbs represented 68.5 percent of the items found in rumen samples. Pussytoes, geranium, aster, dandelion, and cinquefoil were heavily used. In north-central Montana, forbs constituted 54 percent of the vegetation in nine rumen samples, yellow sweet clover being the most predominant plant consumed (Dusek 1975). According to Dusek, Mackie (1970) found yellow sweet clover to be the most important item in the summer diet in the Missouri breaks. Browse species, such as snowberry,

huckleberry, and wild rose, formed 19.5 percent of the forage eaten in Montana. Dusek (1975) found that 43 percent of the summer diet in north-central Montana consisted of deciduous browse species, with buffalo berry constituting 5 of the total 43 percent. McCulloch (1972) indicated that fruits of acacia and mesquite represented 15 and 42 percent, respectively, of the foods taken in an Arizona chaparral area.

In Montana, mushrooms (Q. agaricales) were 12 and grasses only 2 percent of the summer diet. Dixon (1934) observed California mule deer feeding on yard grass, meadow fescue, and spanish clover or deer vetch, the latter of which he indicates to be the most important forage plant in California. In Yellowstone National Park, mule deer feed most frequently on mountain mahogany, red osier, pigweed, dogwood, aspen, red raspberry, buffalo berry, several species of willows, elderberry, dandelion, and clover (Russell 1932). Kufeld et al. (1973) reported that in Colorado shrub and tree consumption averaged 94 percent, and forbs and grasses averaged 6 and 0 percent, respectively. Dietary composition for Rocky Mountain mule deer on the overall range averaged 50 percent trees and shrubs, 47 percent forbs, and 3 percent grasses and grasslike items (Kufeld et al. 1973). Kufeld concluded that consumption of lower forms of forbs, such as mushrooms, increased in the summer months.

Fall Foods (September, October, November): Browse, forbs, and grasses constituted 81, 16, and 30 percent, respectively, of 9 rumen contents. Predominant species taken were snowberry, skunkbush sumac, and rabbit brush (Dusek 1975). Lovaas (1958) reported forbs (53.15 percent) and browse plants (43.8 percent) to be major items taken. The major forbs listed were aster, balsamroot, twinflower, and phlox; Oregon grape was the most used browse type, with juniper ranking second. Dixon (1934) reported that Rocky Mountain mule deer feed frequently

on current bushes, oak, and snowbushes in the early fall and antelope brush in the late fall. He indicated that in California primary foraging occurred on forbs and browse species, with deer brush and dragon sage being of primary importance. McCulloch (1972) reported heaviest use of evergreen and calliandra browse in Arizona in the late fall. Kufeld et al. (1973) found that in Colorado consumption of shrubs and trees averaged 97 percent and forbs 3 percent. On the overall range, mule deer usage of trees and shrubs rose to 60 percent of the diet, while forbs declined to 30 percent and grass/grasslikes averaged 9 percent.

Winter Foods (December, January, February): Lovass (1958) divided winter ranges into forested and prairie types. Rumen analysis showed that browse was the most abundant forage on both ranges (forested 77.9 percent and prairie 47.8 percent). Juniper was the primary browse species, followed by ponderosa pine, Oregon grape, and sagebrush on the prairie type, and kinnikinick, Douglas fir, and Oregon grape on the forested range. Forbs, represented by aster and twinflower, were used less on the forested range than on the prairie range, 19.9 percent and 43.6 percent, respectively. Most prominent prairie range forbs were erigeron and aster. Grasses constituted 1.3 percent of the diet on the forested range and 8.5 percent on the prairie. Dixon (1934) reported that dead sedges (Carex spp.) and snowbrush (Ceanothus spp.) were used heavily by California mule deer in winter months. Staghorn lichen and mosses were readily consumed also (Dixon 1934). Dusek (1975) found that browse and forbs accounted for 60 and 40 percent, respectively, of the rumens sampled. Forb use increased and browse decreased as winter progressed. Rabbit brush and juniper species were the most prominent browse plants. Soapweed (Yucca glauca), the most important forb, accounted for 20 percent of the winter diet, probably because it remained green throughout the winter. Kufeld et al. (1973)

found that in Colorado dietary consumption rates ranged from 94 to 100 percent shrubs and trees, 0 to 4 percent forbs, and 0 to 2 percent grass/grasslike plants. Average percent dietary composition for the Rocky Mountain mule deer over the entire range averaged 74 percent trees and shrubs, 15 percent forbs, and 11 percent grasses, sedges, and rushes.

SHELTER REQUIREMENTS:

Site Preferences: Selection of areas for shelter and bedding vary with season and time of day. During winter, shelter is taken under large trees or bushes on the downhill side and parallel to the contour of the slope, with a view of the area below whenever possible (Bailey 1960). Dusek (1975) noted that mule deer occurred on different slopes in summer and winter. Ridges and sides of coulees and gullies were used during both seasons, with an increased use during winter months. Usage of bottoms and heads of coulees declined abruptly from summer to winter. Excessive *precipitation* resulting in snow accumulation discouraged use of these depressions.

In Daggett County, Utah, on cold sunny days, mule deer occupied southern slopes where snow depth was least and temperatures were highest. Northern slopes were used in spring and fall, but during winter they were abandoned where snow became encrusted. During severe winter storms, deer occupied only 60.5 percent of the area used during normal winters, with upper range limits at 6500- to 7000-ft elevation (Richens 1967). Bailey (1960) illustrated that deer chose sheltered bedding sites during strong winds and changed bedding sites when wind direction shifted on gusty days. During cold weather, deer seem to seek sunny sheltered spots, changing location according to changing shadows (Dixon 1934). Richens (1967) noted that in cold, windy, or stormy weather, Utah deer took cover, particularly in heavy juniper stands. Bailey (1960) found that in Arizona deer sought dense cover in the

heat of the day during spring and summer months, remaining in shady areas until later afternoon. Dixon (1934) states that sites chosen for night shelter are associated with the degree of moonlight present. On moonlit nights, deer seek cover beneath shrubs, such as mountain mahogany and evergreen trees; but on dark nights and overcast days when visibility is reduced, they linger in open grassy meadows with short grasses predominating. Deer tend to take shelter in the same general site each day and may use the same area for several days in succession (Cowan 1956a, as reported in Dorrance 1966).

Materials: Materials used for shelter depend on season and locality. Dixon (1934) reports that Rocky Mountain mule deer prefer a dense screen of mountain mahogany bushes. Fawns may be hidden and bedded in thick clumps of grass or thickets of brush or sagebushes. Dixon once observed a fawn hidden in the narrow crack of a granite boulder. Shelter may be taken in evergreen stands of juniper, cedar, spruce, or pine (Dixon 1934, Richens 1967).

NESTING AND BEDDING REQUIREMENTS:

Site Preferences: The mule deer chooses a bedding site in the same area in which he takes shelter. Dixon (1934) reported that actual bedding sites may differ according to the sex and age of the deer. Mature bucks usually prefer rocky ridges with good visibility of the area below. Dixon (1934) also stated that during hunting season, old bucks bed down in dense shrub and sage thickets throughout the day. Does and fawns in Yosemite National Park bed in open meadows more readily than bucks. Dixon also noted that bedding site preferences of does and fawns differed with locality. He observed that does in Giant Forest, California, usually bedded their fawns at the bases of giant sequoias rather than in open meadows.

Materials: Dorrance (1966) states that deer examine a site thoroughly before bedding, with less care taken in choosing a bed on open ground than on litter, sticks, or stones. Deer

paw to scrape away litter or snow but seldom paw at open grassy ground (Linsdale and Tomich 1953). Dorrance (1966) noted Swank's (1958) observation that Arizona mule deer take daytime shelter under dense cover without apparent choice of site. Dixon (1934) reports that mountain mahogany, incense cedars, and pines are favored cover types, especially in the Rocky Mountains. Linsdale and Tomich (1953) observed that scraping of leaves and soil to the downhill side forms a level ridge on steep slopes. With continuous use, beds result in depressions worked deep into litter, conforming closely to the size and shape of the individual deer's body (Dorrance 1966). The beds are usually single but, in some instances, have been observed in groups of three or four to 1 sq rod. Old bucks tend to avoid snow, preferring a bed of dry leaves in dense cedar or pine stands (Dixon 1934). Dixon reported many beds at the bases of small trees or beneath buckthorn or manzanita bushes in California. Pine needles, short grass, or dry leaves are preferred bedding material among fawns, does, and bucks (Dixon 1934).

RITUAL REQUIREMENTS:

Migration: The mule deer is migratory, spending short summers in the mountains at 7500-8500 ft among evergreens and descending to sheltered valleys and slopes 300-6000 ft above sea level in September or October (Cahalane 1961, Russell 1932). Often summer and winter ranges are as much as 50 to 100 miles apart (Hamilton 1939, Russell 1932). Seton (1927) reported a Colorado locality where migration involved travel over a 150-mile route (Russell 1932). If habitat and vegetation is uniform over the entire range, no migration occurs (e.g. mule deer herds found in Geyser Basins and Firehole Valley) (Russell 1932).

Courtship: During the last months on summer range, the fall molt occurs; antlers are hard and polished. Nearly two months before the breeding season begins, evidences of rut begin

showing in early November, usually among animals at 6500 ft or lower (Russell 1932). Russell states that the bucks manifest a restlessness and a tendency to assume a pose that is strictly characteristic. In the presence of does, a breeding buck will repeatedly lower his head so as to lay his antlers back near his shoulders and stretch his neck to the utmost.

POPULATION STRUCTURE AND TRENDS:

Anderson (1967) states that barring catastrophic events, such as mass starvation, fire, or pesticides, there is little known about the mechanisms that control the size of any population. He also indicates that attempts to measure the "carrying capacity" of an area for mule deer have been largely unsuccessful. However, the mule deer populations and their population structure seem to be governed by seasonal migration patterns, climatic conditions, and hunting season tolls (Russell 1932, Dixon 1934, Richens 1967). Indirect censuses show average Colorado population densities during the winter and early spring that ranged from 28 to 61 deer per square mile. During summer and early fall, Colorado winter range deer densities were from about 9 to 25 deer per square mile (Anderson 1967). In Utah, deer density varied from 81 to 135 per square mile on winter ranges, with an average density during a normal winter in 1958 of 46 per square mile on a 437-square-mile area (Richens 1967). According to Richens (1967), Longhurst et al. (1952) observed an average deer density of 13 per square mile on 88,000 square miles of California deer range, and Swank (1958) observed 10 deer per square mile in Arizona chaparral areas and 70 per square mile on Arizona winter ranges. Dixon (1934) reported 5 mule deer per square mile to be a fairly good deer population on an average range in California. According to Richens (1967), Robinette (1956) recorded a buck, doe, and fawn ratio of 30:100:81 for 174,000 mule deer in 9 western states from 134 to 1950. Richens reports that Gruell and Papez (1963) recorded a buck, doe, and fawn ratio of 45:100:88 in Nevada from 1957 to 1960 and 42:100:80-85 in Daggett County, Utah, from 1958 to 1959. Dusek (1975) stated that

in Utah the fawn and doe ratios based on 640 and 383 deer sighted from ground and aerial observations, respectively, were 104 and 106 fawns to 100 adult does from December 1970 through February 1971. From aerial observations made by personnel of the Montana Department of Fish and Game in December 1967 and January 1969, ratios of 96 and 91 fawns to 100 does were spotted (Dusek 1975). Lovaas (1958) reported a lower productivity rate for an overgrazed Montana range with a fawn and doe ratio of 36:100. Richens (1967) reported the 1958-1960 new productivity of the Daggett County, Utah, range to be 30 percent. Anderson (1967) indicated that population data from the Cache la Poudre range in Colorado suggests a stable or perhaps slightly increasing deer population. Cockrum (1962) listed sex ratios of mule deer at various ages in terms of the number of females to 100 males. Embryonic stages showed 90 females (sample size - 2,299); at birth, 83 females (sample size - 807); and immature stages, 88 females (sample size - 13,046). No figures were given for adult deer.

REPRODUCTION AND SURVIVAL:

Mating Habits: Dixon (1934) reports that early in November before the majority of the deer have reached their winter range, the rut begins, being first evident among animals at elevations of 6500 ft or below. Actual breeding seasons of the mule deer take place in November and December (Hall and Kelson 1959). Breeding occurs once a year, and the gestation period in the mule deer is approximately seven months (Dixon 1934).

Family Structure: During breeding season, the dominant bucks win a harem of three to four does. Mature does may produce one to three fawns in May, June, or early July (Hall and Kelson 1959). Cahalane (1961) noted that young does and those in poor condition usually have one fawn. Fawns weigh 6 to 10 lb at birth and are capable of strong running when about a month old (Cahalane 1961). Fawns are kept hidden for 6 to 8 weeks (Palmer and Fowler 1975). Weaning takes place at approximately 2 to 2-1/2 months of age (Dixon 1934); however, fawns

follow the doe throughout the summer and the first winter. Young does may follow her for two years (Palmer and Fowler 1975). Young mule deer may bear young at the age of two years (Dixon 1934).

Longevity: The average life span of the mule deer is 16 years (Palmer and Fowler 1975). In typical Colorado herds, few deer aged nine years or older are taken by hunters (Anderson 1967).

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APPENDIX C: NARRATIVE FOR PRONGHORN

FAMILY:

Scientific Name: Antilocapridae (Jones et al. 1975)

Common Name: Pronghorn.

SPECIES:

Scientific Name: <u>Antilocapra americana</u> (Jones et al. 1975)

Common Name: Pronghorn (Jones et al. 1975, Leister 1932), Pronghorn antelope (Noback 1932, Palmer and Fowler 1975), antelope (Cahalane 1961), Pronghorned antelope (Bailey 1920, Nelson 1925), Prong-horn antelope (Nichol 1942), Prong-horn (Skinner 1922), Prong-horned antelope (Leister 1932, Bailey 1920).

LEGAL STATUS:

The pronghorn is protected by state game laws in Arizona, California, Colorado, Idaho, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, and Wyoming, and provincial game laws in Saskatchewan (Barnes et al. 1971). "Worthy of more protection from hunters, at present their worst enemy" (Palmer and Fowler 1975).

These animals are often enticed within shooting range by their own curiosity (Cahalane 1961, Irving 1836, Leister 1932, Nelson 1925, Palmer and Fowler 1975, and Skinner 1922). Skinner (1922) states that killing of pronghorn was widespread in the 1800's; and although there were laws against illegal hunting, no punishment was provided for persons breaking these laws (even in Yellowstone National Park where punishments went into effect in 1894). "For centuries the species furnished meat, hides, and tableware for the Plains Indians. Then the white people came, and for a few decades antelope steaks were the most common palatable meat on the bill of fare along the covered wagon routes from the Mississippi to California and Oregon" (Cahalane 1961). Cahalane (1961) also states that "fencing, plowing, and livestock grazing cut up the antelopes' habitat and depleted their supply of food."

VALUE POTENTIAL, POSITIVE:

Recreational: The species is hunted in all states in which it occurs (Barnes et al. 1971).

Scientific: Cahalane (1961) states that the pronghorn is the only native American of all the hoofed animals; and although he is referred to by some as an antelope, he is "...not even a second cousin of the African and Asian antelope." His ancestry has been traced to "...a practically identical forebear in the early Pleistocene, between one and two million years ago" (Cahalane 1961). "It is the sole representative of its genus and family, for the peculiarities of its horns and their growth are deemed sufficient to justify a separate family, intermediate between the giraffes (Giraffidae) and the Bovidae" (Skinner 1922).

Aesthetic: The pronghorns are regarded by some authors as a beautiful animal (Palmer and Fowler 1975), quite "...striking in appearance" (Cahalane 1961).

Ecological: Shed-horn sheaths, when softened by rain or snow, serve as food for coyotes and badgers. Additionally, horns are gnawed by porcupines, ground squirrels, mice, gophers, prairie dogs, and even pronghorn themselves to renew their supply of calcium (Cahalane 1961, Skinner 1922).

VALUE POTENTIAL, NEGATIVE:

Ecological: Palmer and Fowler (1975) state that pronghorn compete with grazing animals for food. "A very serious and frequently fatal malady...actinomycosis or 'lumpy jaw' may be transmitted to man, and sometimes it is fatal" (Cahalane 1961).

DESCRIPTION:

Documents with Illustrations: "The Mammals of North America" (Hall and Kelson 1959); "Mammals of North America" (Cahalane 1961); "American Mammals" (Hamilton 1939).

Physical Appearance: The pronghorn is smaller than a deer but "...much more striking in appearance" (Cahalane 1961). Its physical characteristics include a length of 4 ft (with a

3-in. tail), a shoulder height of 3 ft (total height of 4 ft), approximate weight of 138 lb (females, 10 percent less), colors of tan and white (bucks darker) (Hall and Kelson 1959, Palmer and Fowler 1975). It has only two toes on each foot and has lost all bony remnants of the lateral toes (dew claws) of its ancestors (Cahalane 1961). Eyes are "prominent and set well to the sides of his face," and they can "cover a wide range without movement of the head" (Cahalane 1961).

Field Marks or Distinguishing Characteristics: The body has "immaculate white underpinning and buttocks. Black horns, dark markings on the face, and bands around the throat are decorative accents. The shining black eyes, with big eyelashes, are bigger than those of the much larger horse" (Cahalane 1961). It has a white rump patch (called a "heterographic patch" by Nelson (1925)), which "...stands out very prominently, especially when the pronghorn is excited; and when the antelope is in flight, it is clearly visible long after the animal is hardly distinguishable" (Noback 1932). The pronghorn has "branched or prong horns and has the unique characteristic among all hollow-horned animals of shedding the outer covering of the horns annually" (Nelson 1925).

RANGE:

The pronghorn ranges in the western plains from southern Alberta and Saskatchewan (latitude 51°N) to Baja California, and to the central Mexican states of San Luis Potosi and Hidalgo (latitude 21°N) and from west-central California (longitude 122°W) to western Iowa and Minnesota (longitude 96°W) (Hall and Kelson 1959).

HABITAT:

Climate: Temperatures in the range of the pronghorn vary from normal daily minimums of -10° to 40°F in January and normal daily maximums of 70° to 100°F in July. Mean annual total precipitation ranges from 4 to 64 in., and mean annual total snowfall varies from less than 1 in. in the southern part of the range to more than 100 in. in the northern part of the

range. Three fourths of the annual precipitation over the range occurs from April to September. Wind speeds and directions are extremely varied. Mean daily lowest relative humidity varies from 15 to 60 percent; mean daily highest relative humidity varies from 40 to greater than 80 percent. The range mean annual pan evaporation is from 35 to 140 in. The mean daily solar radiation varies from less than 350 to 550 Langleys. Normal sea level pressure ranges from 1012 to 1016 mb. The preceding data were abstracted from Baldwin (1973).

Topography: The range of the pronghorn includes the following entire physiographic provinces in North America: Great Plains, Southern Rocky Mountains, Wyoming Basin, Middle Rocky Mountains, Colorado Plateaus, and the Basin and Range Province. Also included in the range are portions of the following physiographic provinces: Central Lowlands, Northern Rocky Mountains, Cascade-Sierra Mountains, Pacific Border (Fenneman 1931). Fenneman (1931) states that relief ranges from "low" to "strong" (i.e. local relief approaching 1000 ft), and that elevations range from below sea level (Death Valley) to greater than 14,000 ft (Rockies, Cascades, etc.).

The pronghorn, however, tends to favor the open prairie of the western plains (Burt 1952, Cahalane 1961, Palmer and Fowler 1975). Morris (1965) states that the "species can be found in...wild, rocky desert country where their creamy colour blends in with the background, and the cartilaginous pads on their feet allow them to travel quickly and quietly."

Natural Vegetation: According to Kuchler (1964), the potential natural vegetation over the entire range of the pronghorn includes dense needleleaf evergreen forest, open forest of needleleaf evergreen trees (e.g. *Pinus ponderosa*), "open groves of needleleaf evergreen low trees with varying admixtures of shrubs and herbaceous plants" (dominates, e.g. *Juniperus monosperma*, *Pinus edulis*), and broadleaf western

deciduous forest to open grasslands and savannas. The pronghorn tends to prefer the open terrain of the Great Plains (Palmer and Fowler 1975) and "...the broad interior valleys of the mountains" (Skinner 1922). There are, however, exceptions to this general rule, as Skinner (1922) states that he has observed pronghorn in "...more or less open, stunted growth consisting of aspen, willows, or Douglas fir..." Pronghorn also seem to show no hesitancy in entering timber to escape when they are frightened (Skinner 1922). Skinner (1922) reports that in the southwestern United States, pronghorns can habitually be found in the open yellow pine forests.

Animal Associates: Enemies include the coyote (Skinner 1922), although Cahalane (1961) believes that the coyote is not as great a threat as it was once supposed to be, since "...there are many other foods easier for him (the coyote) to secure." Other predators are the golden eagle, wolf, bear (Cahalane 1961, Skinner 1922), mountain lion (Skinner 1922), and bobcat (Morris 1965). Very small kids used to occasionally fall prey to the buffalo (Skinner 1922).

"...An antelope's disposition is to avoid all other animals. Occasionally they are with deer, elk, mountain sheep, and even buffalo, but the association is due to limited forage and not at all to sociability" (Skinner 1922). They "...always shy off from the larger animals, do not relish their proximity, and even go so far as to decline forage over which elk and domestic sheep, cattle, or horses have grazed" (Skinner 1922). Cahalane (1961) believes that "disease is perhaps a greater factor in antelope existence than predators." He cites as dangerous several external parasites, including ticks, lice, and mites, and internal parasites, including flatworms and roundworms. Skinner (1922) gives a more detailed list of internal parasites, which are of "...several kinds that infest domestic sheep, goats, and cattle--tape worms, stomach worms, whip worms, and hair worms."

FOOD HABITS:

"Pronghorns, like other ruminants, are not known to take animal food purposely. Many kinds of plants are consumed, but particularly prominent in the diet are the foliage and twigs of the woody species. Sagebrush is an outstanding antelope food. Grasses, weeds, and other nonwoody plants are also eaten freely. In very arid regions, succulent plants serve as the only source of water" (Martin et al. 1951). Skinner (1922) states that pronghorns "...eat snow in preference to hunting up the scarcer open waters." Cahalane (1961) lists atriplex, rabbit brush, greasewood, and Russian thistle as important foods and discusses their eating habits as follows: "At all times the antelope is a dainty eater. It feeds thriftily and does not trample down and discard undesired plants as do some other big game species. Like all hoofed animals it relishes the salt licks." Tender grasses (e.g. gramma and buffalo grass) are important food preferences, and the animals will seek their green sprouts out of the heads of bunchgrasses (Cahalane 1961). "Their delicate lips are well adapted to picking the seed-laden heads and capsules of grasses and other plants..." (Bailey 1931). Cahalane (1961) also states that the species is fond of oats, alfalfa, and other crops and that they sometimes inflict considerable damage to cultivated fields; they are able to squeeze through fences with relative ease. Martin et al. (1951) provide a list of foods by geographic regions, by preference, and by season. "Their hours for feeding are irregular, but when they are feeding, pronghorns crop their food for about an hour, then lie down and 'chew the cud' for thirty to forty minutes before resuming grazing" (Skinner 1922). Pronghorns are "...quieter during the night and not given to moving about nor eating so much as in daytime," and "...quiet after they spend nights on hills and elevations and move down to the valleys to feed in the mornings" (Skinner 1922). When there is an abundant supply of food, pronghorns become fat and strong, and their offsprings develop more rapidly (Bailey 1931, Skinner 1922).

SHELTER REQUIREMENTS:

"As a rule, prong-horns confine themselves to the great open plains and the broader interior mountain valleys" (Skinner 1922). Skinner (1922) also reports sightings in open wooded areas. "Antelope are in every way a product of the open country, depending for protection on alertness, speed, numbers, and a clear field for escape" (Bailey 1931). The wide plains and open valleys provide the needed food and a clear field of view "...where a few (pronghorns) on guard could give fair warning, then white signal flashes (on their rumps) showing far and their sharp snorting whistles still further warning the herds of approaching danger" (Bailey 1931). "Unless there is a scarcity of food, individuals of the antelope tribe remain within a small area of a few hundred acres" (Skinner 1922). Although pronghorns possess an ability to run fast and far over rocky terrain, they are "...not erratic wanderers" (Cahalane 1961). They do migrate seasonally, however, spending summers on the higher ranges (windswept plains) and winters in the lower valleys to escape the deeper snow (Bailey 1931, Cahalane 1961, Skinner 1922).

NESTING AND BEDDING REQUIREMENTS:

Pronghorn does retire in late May or early June "...to some secluded spot where the kids are born, usually two at one time" (Skinner 1922). Cahalane (1961) states that the doe may deliver her young "...in a little 'park' in a pine forest, or, more likely, she may choose the top of a knoll or ridge on the open plains, perhaps only one or two hundred yards away from the band," but he further states that "most likely they are just dropped anywhere."

RITUAL REQUIREMENTS:

"Antelopes are highly polygamous, and early in the autumn the bucks, now with horns well hardened, begin to show signs of excitement" (Bailey 1931). Smaller and weaker bucks are driven out by the stronger bucks, and usually the contests do not develop into a battle; where fighting does develop, it can be fierce (Bailey 1931, Skinner 1922). Cahalane (1961) describes a vicious fight in Yellowstone National Park where a victorious buck not only wounded

his opponent but also dug his horns into the prostrate animal and tore out the vitals. Courtship itself may be considered a ritual, as bucks pursue does who permit themselves to be caught each mating season (Cahalane 1961, Skinner 1922). Herding and migration of the herds are also rituals; Bailey (1931), Cahalane (1961), and Skinner (1922) describe the movement of the herds from the summer feeding grounds, the windswept plains, to the wintering areas, the protected valleys. Single animals or pairs of animals are usually bucks that either have been excluded or have chosen to exclude themselves from the herd (Skinner 1922). Skinner (1922) also points out that for a three-month period beginning around the first of November, pronghorn form bands for mutual protection, and during this period (which corresponds to the bucks horn-growing season), the bands are led by does, even though several large bucks may be present. After the rutting season, the animals form larger bands of 50 to 100 (Cahalane 1961). In the early to middle part of the ninteenth century, these herds may have consisted of thousands of pronghorns, and Skinner (1922) tells of reports where migrating animals wore paths in the hard soil to depths of 10 in.

POPULATION STRUCTURE AND TRENDS:

The first sightings of the pronghorn by Europeans (1723) reported their presence over an enormous part of North America, covering an area greater than that occupied by the buffalo. Its numbers were conservatively estimated at "...not less than 30-40 million, and possibly more" (Nelson 1925). Population estimates of the pronghorn in Yellowstone National Park from the superintendent's annual reports range from "thousands" in 1877 to "300" in 1920 (Skinner 1922). The population of pronghorn has risen from slightly over 30,000 in 1922-24 (Nelson 1925) to a 1949 population of 165,000 (Palmer and Fowler 1975). "Conservation practices were applied in time to save the antelope from extinction...With a limited area and food supply, some ranges in New Mexico, Colorado, Wyoming, the western Dakotas, and Montana have become fully stocked. Annual hunting kill of approximately ten thousand antelope is now (1961)

safe. Methods of capturing and transplanting this animal to new ranges have been worked out" (Cahalane 1961). "With present knowledge and experience in game and wildlife control, there should be no difficulty in maintaining as many antelope as desired in any suitable areas where summer and winter food is available for them" (Bailey 1931).

REPRODUCTION AND SURVIVAL:

Phenology: Pronghorn breed in August and September following the fighting of the bucks of the herd (Hall and Kelson 1959). Cahalane (1961) states that pronghorn may breed as late as October in the more northern latitudes.

Mating Habits: The victorious bucks form harems of three to four does each (or sometimes even only one doe), and "it takes a very enterprising buck to control eight mates" (Cahalane 1961). Palmer and Fowler (1975) report that harem size may be as large as 15 does. Skinner (1922) states that courtship "...seems to consist largely in swift running matches wherein the doe runs away from the buck or suffers herself to be caught, as she sees fit, for she is evidently the speedier of the two."

Family Structure: "...The young (average 1.5) are born after a gestation period of 230-240 days"; twins are common, but triplets are rare (Hall and Kelson 1959). Fawning occurs in late May or early June, and compared with deer or elk, the young pronghorn is "...unusually strong and reliant" (Skinner 1922).

Survival Rates: Skinner (1922) reports that the young are "...efficient in their fight for existence" and that this is demonstrated by the number that survive the first year. He observed that in the spring of 1921, 19 percent of the herd in Yellowstone National Park were young pronghorns approaching one year old. Although the young are hardy creatures, the mother is very protective, even placing twins "...seventy-five to one hundred yards apart" (Cahalane 1961), and "she

uses her sharp hoofs with fine effectiveness, striking a quick, downward blow with her forefeet that easily disables a coyote or similar foe" (Skinner 1922).

Longevity: Palmer and Fowler (1975) state that the life span is 10 years. Skinner (1922) and Cahalane (1961) report that in captivity these animals are extremely nervous, subject to disease and dietary difficulties, and rarely live longer than one year.

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APPENDIX D: NARRATIVE FOR BLACK-TAILED PRAIRIE DOG

FAMILY:

Scientific Name: Sciuridae (Jones et al. 1975)

Common Name: Squirrels

SPECIES:

Scientific Name: *Cynomys ludovicianus* (Jones et al. 1975)

Common Name: Black-tailed prairie dog

LEGAL STATUS:

The state of South Dakota and the U. S. Bureau of Sport Fisheries and Wildlife have leased several parcels of land to protect and preserve prairie dog towns where black-footed ferrets have been known to occur (Hillman and Linder 1973).

VALUE POTENTIAL, POSITIVE:

Recreational: Prairie dogs are hunted for sport in most of the states in which they occur (Smith 1967, Linder 1973). "'Varmint hunting' or 'target practice' has been a Sunday afternoon pastime for more than a hundred years in prairie dog country..." (Koford 1958).

Scientific: The continued existence of the black-footed ferret (an endangered species--Federal Register 1974) depends upon the preservation of prairie dog towns for its habitat (Hillman and Linder 1973). "Although people disagree on how management should be carried out, most agree that management of the black-footed ferret is dependent upon management of the prairie dog" (Linder 1973).

Ecological: Prairie dogs influence range soils directly by mixing deep and surface soils, enriching the soil, and because of the depth of their burrows, increasing the penetration of air and water into the soil (Koford 1958).

VALUE POTENTIAL, NEGATIVE:

Commercial: Several authors over a period of more than 70 years have reported that prairie dogs eat, cut, trample, and bury many plants within the land area of their towns to the

detriment of the land area used for livestock grazing or other agricultural purposes (Bailey 1926, Bell 1921, Merriam 1902, Taylor and Loftfield 1924). Koford (1958) discusses the findings of these earlier workers and indicates that there may have been a tendency to "overemphasize rodent damage." Kelso (1939) made a quantitative study of the foods of the black-tailed prairie dog in Montana. His analysis of the stomach contents of 247 black-tailed prairie dogs indicated that herbage of some value to livestock comprised 76.19 percent of the stomach contents and that 22.41 percent was of little or no value for grazing animals. Koford (1958) estimates that "...the number of prairie dogs equivalent to one cow in green forage consumption is 335" but indicates that other factors make it "...impossible to determine the degree of competition between rodents and cattle on the mere basis of relative numbers or animal unit equivalent."

Ecological: Fleas that are associated with the black-tailed prairie dog harbor the bubonic plague bacillus (Pasteurella pestis) (Erickson 1973).

DESCRIPTION:

Documents With Illustrations: "The Mammals of North America" (Hall and Kelson 1959); "Mammals of North America" (Cahalane 1961).

Physical Appearance: "A plump-bodied, rather large rodent with flattened head, low, rounded ears, short legs, and short, slender tail. Fur rather coarse, close to body. Color pale buffy to pinkish cinnamon grizzled with blackish, grading into white on under parts; terminal one-fifth to one-half of tail black. Total length, 12 to 15-1/2 inches; height at shoulder, 5 inches; weight, 1-1/2 to 3 pounds" (Cahalane 1961).

Field Marks or Distinguishing Characteristics: "Tail tipped with black; jugal heavy, thick, the outer surface at angle of ascending ramus presenting a broad, triangular surface" (Hall and Kelson 1959).

Critical Taxonomic Criteria: "Black on tail confined to distal

third; posterior border of inflected angle of mandible at angle of approximately 45 deg to axis of jaw" (Hall and Kelson 1959).

RANGE:

The range of the black-tailed prairie dog corresponds with the area of the Great Plains Physiographic Province, a zone about 400 miles wide extending eastward from the foothills of the Rocky Mountains to the edge of the central lowlands (Koford 1958). This includes extreme southern Saskatchewan, east to west-central North Dakota, south to southwestern Texas, west to southeastern Arizona, and north to north-central Montana (Hall and Kelson 1959).

HABITAT:

Climate: Temperatures in the range of the black-tailed prairie dog vary from normal daily minimums of 40°F in the south to -5°F in the north in January and normal daily maximums of 95°F in the south to 85°F in the north in July. Precipitation ranges from a mean annual total precipitation of 32 in. on the eastern edge of the range to a total precipitation of 12 in. along the western edge of the range. Mean annual total snowfall varies from less than 1 in. in the southern part of the range to more than 36 in. in the northern part. Three fourths of the annual precipitation over the range occurs from April to September. Wind speed and direction are extremely varied with speed extremes occurring in tornadoes or chinooks. Mean daily lowest relative humidity ranges from 40 percent in the western part of the range to 60 percent in the eastern. Mean daily highest relative humidity ranges from 70 percent in the western part of the range to 90 percent in the eastern. Mean annual pan evaporation varies from 120 in. in the southern part of the range to 40 in. in the northern. Mean daily solar radiation ranges from 500 Langleys in the southern part of the range to 350 Langleys in the northern part. Normal sea level pressure varies from 1014 mb in the southwestern part of the range to 1016 mb in the northeastern

part. The above data were abstracted from Baldwin (1973). There are very few studies that include data on climatic conditions surrounding black-tailed prairie dog towns. Sheets (1970) indicated that he measured temperatures of 70°-95°F and wind speeds of 0-20 mph in towns in South Dakota. Vogel et al. (1973) measured wind speeds of 68-196 cm sec^{-1} in a town in Kansas. Koford (1958) reported that Anthony (1955) carried on temperature experiments with prairie dogs from Oklahoma and discovered a dormant state in prairie dogs that he called "cold narcosis." This state was produced only when succulent food was withheld at temperatures ranging from -40° to +60°F. Anthony (1955) did not call this state hibernation, since it took several days for the prairie dogs to recover once they were warmed. Koford (1958) indicated that he saw prairie dogs aboveground in Colorado at a temperature of 17°F. Smith (1967) reported that humidity had no noticeable effect on prairie dogs but that they did remain in their burrows during rain and snow storms. He also indicated that winds up to 35 mph did not seem to affect prairie dogs. He found that because of summer temperatures of 100°-112°F, prairie dogs did change their feeding and aboveground activities to the cooler early morning and late afternoon hours. He reported that burrow temperatures in the summer varied from 74° to 76°F. Several prairie dogs that were held outdoors aboveground in laboratory cages died after three days of exposure to 108°F temperatures (Smith 1967).

Topography: The Great Plains Physiographic Province is a zone about 400 miles wide extending eastward from the foothills of the Rocky Mountains to roughly the 99th meridian (Fenneman 1931, Koford 1958). This province corresponds with the range of the black-tailed prairie dog (Koford 1958). The eastern boundary follows roughly the 1500-ft elevation contour line, except at the north where it rises to 2000 ft (Fenneman 1931). The western boundary at the foot of the Rocky Mountains

averages 5500-ft elevation with a range of 1000 ft above and below that elevation (Fenneman 1931). Fenneman (1931) divided the province into 10 sections and states that each of these embraces a variety of topographic types. He indicates that the province is largely made up of remnants of a single great expanse of fluviatile plain or alluvial slope, which is known to have spread from the mountains on the west and presumably reached to the central lowland. The eastern margin has been most exposed to erosion and is dissected by several drainage systems. The western edge has also been subject to erosion, and the northern section to glaciation. A mountain uplift in the Black Hills section and some smaller mountain groups in Montana have also changed the basic plain. The erosion of the Edwards limestone is the most important feature of the southern section of the province (Fenneman 1931). "It is characteristic of plateau dissection to begin at the outward-facing edges and to progress inward as the streams lengthen headward" (Fenneman 1931). The average slope across the province is approximately 10 ft per mile (Fenneman 1931). Armstrong (1972) reported that in Colorado "only locally does the species find access to grasslands of the foothills. The highest locality of record is conifer, on Turkey Creek in Jefferson County, 7300 feet. More typically, the upper limit is about 6000 feet." Soper (1938) reported black-tailed prairie dogs at elevations from 2600 to 3600 ft in Canada. Sheets et al. (1971) found prairie dog towns in South Dakota on slopes up to 30 deg. They stated that a slope of 35-45 deg apparently inhibited expansion of one town. Koford (1938) found that towns on level ground are rare and theorized that this was because low or level ground was subject to flooding or lack of variety of food, as compared to adjacent slopes. He states "...the steepness of slope that limits growth of a dog town decreases from approximately 30 percent in the north to 10 percent in the south." He found 15 percent slope to limit towns

in Colorado and stated that a town usually starts on a gentle slope and expands upslope onto steeper ground. "In any limited area, ground above a certain degree of slope will rarely be occupied by prairie dogs. This fact is of practical value in judging the potential area that a dog town may occupy if left undisturbed, as in a preserve" (Koford 1958).

Soil: The soils in the range of the black-tailed prairie dog are of fluviatile origin, and the material is largely unconsolidated silt with smaller quantities of sand and gravel (Fenneman 1931). These soils are in part eolian and not to be correlated rigidly with the underlying rock. There are broad areas covered with a surface sheet of loess, which is to be expected in an arid climate where wind is a transporting and assorting agent (Fenneman 1931). Sheets et al. (1971) found that prairie dogs in South Dakota dug burrows in soils that they describe as "...solidized solonetz with a thin, friable surface layer underlain by a dense, dispersed clay layer. The grayish brown clay, silt loams, and sandy loam soils are well to excessively drained." Koford (1958) stated that "the black-tailed prairie dog occurs in a region that includes many soil associations, principally brown and chestnut soils, and chiefly on the clay uplands range site." Reid (1954) working in the Theodore Roosevelt National Memorial Park found that more than half of 28 dog towns were on clay loam soils, which were chiefly in narrow belts on valley slopes of from 7.5 to 0.5 percent grade. "Steep slopes, dissected valleys, clinker-beds, and shallow soils appeared to be barriers to the growth of dog towns" (Koford 1958). He also reported that on other parts of the Great Plains Province most dog towns were on deep alluvial soils of medium to fine texture, and that while new towns might always start on loam, within and bordering old towns, prairie dogs may dig burrows in any soil that can be dug without immediately caving in. "Because burrows occur in many kinds of soil, the distribution of prairie dogs does not

seem to be limited directly by soil composition or texture; more important are the indirect effects of soil texture on moisture and vegetation" (Koford 1958).

Natural Vegetation: Koford (1958) indicates that the vegetation of the Great Plains Province progresses from short grasses through midgrasses to tall grasses as one travels eastward from the foot of the Rocky Mountains, because the precipitation, and therefore the moisture, available to the grasses increases. He also states that "prairie dogs are characteristic of the short-grass plains, and the eastern limit of their distribution corresponds fairly well with the western edge of the tall-grass association." Kuchler (1964) mapped the potential natural vegetation of the United States, indicating that the following dominant vegetation types are along the foothills of the Rocky Mountains (from north to south):

Bluebunch wheatgrass	(*Agropyron spicatum*)
Idaho fescue	(*Festuca idahoensis*)
Rough fescue	(*Festuca scabrella*)
Needle-and-thread grass	(*Stipa comata*)
Western wheatgrass	(*Agropyron smithii*)
Blue grama	(*Bouteloua gracilis*)
Buffalo grass	(*Buchloe dactyloides*)
Tarbush	(*Flourensia cernua*)
Creosote bush	(*Larrea divaricata*)

The dominant vegetation in the eastern portion of the range of the black-tailed prairie dog are (from north to south):

Western wheatgrass	(*Agropyron smithii*)
Blue grama	(*Bouteloua gracilis*)
Needle-and-thread grass	(*Stipa comata*)
Green needlegrass	(*Stipa viridula*)
Big bluestem	(*Andropogon gerardi*)
Needlegrass	(*Stipa spartea*)
Buffalo grass	(*Buchloe dactyloides*)
Little bluestem	(*Andropogon scoparius*)
Side-oats grams	(*Bouteloua curtipendula*)
Sand bluestem	(*Andropogon hallii*)
Sand sage	(*Artemisia filifolia*)
Hairy grama	(*Bouteloua hirsuta*)
Sand reed	(*Calamouilfa longifolia*)
Mesquite	(*Prosopis juliflora*)

The Kuchler vegetation type numbers for the western half of

the prairie dogs range are 63, 64, 65, and 59; and for the eastern half of the range, 66, 67, 69, 70, 75, and 85. Soper (1938) reported that the vegetation within or adjacent to the towns he found in Saskatchewan included the following:

Willow	(_Salix_)
Snowberry	(_Symphoricarpos_)
Buffalo berry	(_Lepargyrea_)
Prairie rose	(_Rosa_)
Sagebrush	(_Artemisia_)
Greasewood	(_Sarcobatus_)
Prickly pear	(_Opuntia mammallaria_)
Grama	(_Bouteloua_)
Buffalo pea	(_Astragulus_)

Sheets (1970) and Kelso (1939) both state that the black-tailed prairie dog is usually found in short-grass prairie. Kelso (1939) lists the following nine species of plants as dominant in the prairie dog habitats he studied.

Grama	(_Bouteloua gracilis_)
Russian thistle	(_Salsola pestifer_)
Blue grasses	(_Poa_ spp.)
Buffalo grass	(_Buchloe dactyloides_)
Prickly pear	(_Opuntia_ spp.)
Wheatgrass	(_Agropyron_ spp.)
Winterfat	(_Eurotta lanafa_)
Saltbushes	(_Atriplex_ spp.)
Sages	(_Artemisia_ spp.)

"In Colorado, the species occupies areas of short- and mixed-grass prairie and occurs throughout the eastern part of the state" (Armstrong 1972). According to estimates by Koford (1958), tall perennial grasses (over 1 ft) appear to be an effective and resistant barrier to the expansion of dog towns. He further indicates that tall, dense forbs and shrubs are also effective barriers. Pete Jensen, a range conservationist in Dodge City, Kansas, states that in the 20- to 24-in. precipitation belt he found prairie dogs on a poor to low-fair range condition class or a range of 10 to 30 percent climax (Koford 1958). Koford (1958) quotes Jensen as saying that "these are ranges covered almost entirely with buffalo grass and blue grama. We believe climax on the medium-textured

soils or the ordinary upland range site consists of no more than 10 percent buffalo grass and 30 percent blue gramma. I believe the highest percentage of climax that I have observed their [prairie dogs] invading would be approximately this 40 percent level." Jensen also adds that "while in the 15- to 19-in. precipitation belt, I find prairie dogs on ranges in a poor to high-fair condition or 20 to 50 percent of climax. On the medium-textured soils or the ordinary upland range site, climax consists of no more than 20 percent buffalo grass and 40 percent blue grama. I believe the highest point of climax they will invade in this precipitation belt would be 60 percent. I would state the prairie dog tends towards a buffalo grass-blue grama disclimax. I find these dogs only on short-grass ranges, namely buffalo grass and blue grama, and never invading a range that has any mid or tall grasses with the exception of a rare silver blue-stem plant." "These observations strongly suggest that prairie dogs rarely start new towns on ranges in good to excellent conditions" (Koford 1958).

Animal Associates: Many animals are known to occur in or near black-tailed prairie dog towns. Table D1 lists these animals. Of those listed the black-footed ferret is of particular importance, since it has been classified by the U. S. Department of Interior as an endangered species (Federal Register 1974). The black-footed ferret is one of several predators of the prairie dogs. Other predators, which will take either adult or yound prairie dogs, include: golden eagle, rough-legged hawk, ferruginous hawk, red-tailed hawk, marsh hawk, prairie falcon, coyote, bobcat, badger, rattlesnake, bald eagle, and burrowing owl (Koford 1958).

FOOD HABITS:

There have been several studies on the types of food eaten by black-tailed prairie dogs (Kelso 1939, Koford 1958, Martin et al. 1951, Smith 1967). These studies have been based primarily upon

analysis of stomach contents. Table D2 lists the vegetation that these authors have reported as eaten by black-tailed prairie dogs. Koford (1958) reports that based on Kelso's (1939) data on volume percentage of food consumed, the plants with the highest yearly percentages were: western wheatgrass, 12 percent; fescue (chiefly six-weeks fescue, Festuca octoflora), 9 percent; Russian thistle, 7 percent; prickly pear (Opuntia), 6 percent; and saltbush (Atriplex), 4 percent. Kelso (1939) reports that animal matter eaten included: cutworms (Nocturdae), spiders (Arachnida), short-horned grasshoppers (Acrididae), bugs (Heteroptera and Homoptera), cicadas (Cicadidae), ground beetles (Carabidae), leaf beetles (Chrysomelidae), weevils (Curculionidae), and robberflies (Asilidae). Kelso (1939) summarized his findings on the food habits of the black-tailed prairie dog as follows: "Herbage of some value to livestock comprised 76.19 percent, and that of little or no value for grazing 22.41 percent of the food of the black-tailed prairie dog. Plants of the grass family predominated in the annual food, comprising 61.55 percent, and those of the goose-foot family were second, totaling 12.73 percent. Of the valuable forage plants, wheatgrasses were eaten in greatest quantity and fescue next. Animal matter, mostly cutworms eaten during the spring months, furnished 1.40 percent of the food." The moisture intake requirements of prairie dogs does not depend upon drinking water, since sufficient moisture is obtained from its food (Kelso 1939).

SHELTER REQUIREMENTS:

Site Preferences: The black-tailed prairie dog is a social burrowing animal, living in communities called dog towns of varying extent, sometimes covering many square miles (Warren 1910). Bailey (1931) states that "an old and successful prairie dog town is usually located on wide-open and mainly level ground where an unobstructed view is to be had on all sides and no enemy can approach without being discovered by some watchful sentinel." Koford (1958) indicates that the

site factors of importance are slope, vegetation, and soil type. The maximum slope reported in a dog town was 30 deg (Reid 1954), and Koford (1958) indicates that the maximum slope where dog towns are located decreases from a maximum of 30 deg in the northern part of the black-tailed prairie dog's range to 10 deg in the southern. Sheets et al. (1971) indicate that slopes of 35-45 deg limited dog town expansion in South Dakota. Steep slopes, dissecting valleys, clinkerbeds, and shallow soils appear to be barriers to the growth of dog towns (Koford 1958). Furthermore, Koford (1958) reports that most dog towns in the Great Plains Province were on deep alluvial soils of medium-to-fine texture, and that while new towns might always start on loam, within and bordering old towns, prairie dogs may dig burrows in any soil that can be dug without immediately caving in. In South Dakota, prairie dogs dug burrows in grayish brown clay, silt loams, and sandy loam soils (Sheets et al. 1971). Vegetation within and bordering the dog towns is often characterized as short-grass prairie (Armstrong 1972, Kelso 1939, Koford 1958), and the dominant plants include: blue grama (Bouteloua gracilis), buffalo grass (Bachloe dactloides), Russian thistle (Salsola kali), bluegrasses (Poa spp.), prickly pear (Opuntia spp.), wheatgrasses (Agropyron spp.), winter fat (Eurotia lanata), saltbushes (Atriplex spp.), and sages (Artemisia spp.) (Kelso 1939, Kuchler 1964).

Materials: Smith (1967), discussing the characteristics of burrows in Kansas, stated that permanent burrows are usually dug in spring or autumn with exploratory burrows 2 or 3 ft long being dug in summer. Only one individual digs at a time and may dig the whole burrow itself or occasionally be relieved by another prairie dog. Sheets et al. (1971) indicate that a typical prairie dog burrow system consists of a dome-shaped mound with a central entrance leading to a tunnel that typically slopes 15-20 deg. This tunnel ranges from

4 to 14 ft deep and 13 to 109 ft long. The tunnels are 5 to 15 in. in diameter and enlarge to 8-10 in. at junctions with side branches. Side pockets or nest chambers were found in 9 of 18 systems. At some point, the tunnel makes an abrupt vertical ascent to another entrance, which is typically in the center of a crater-shaped mound. All dome-shaped mounds consist of subsoil material; crater-shaped mounds consist of compacted surface soil mixed with grass. Smith (1967) indicates that the mounds in Kansas vary from 3 to 10 ft in diameter. He reports that most burrows on sloping terrain tend to have their openings in the direction of downward slope; data on those on the level (less than 5 deg slope) show no general pattern. He states that burrows that extend straight down 6 ft or more have rim-type mounds, burrows that have a sharp incline have dome-type mounds, and burrows on the 15- to 20-deg slopes show little attempt at construction of permanent mounds. He states that the prairie dog excavates its burrow system beginning with the sloping entrance and finishes by digging upwards to the vertical entrance. Both Sheets et al. (1971) and Smith (1967) report that sections of the tunnel of the burrow system may be sealed with soil. Smith (1967) states that introduction of dead prairie dogs into burrows resulted in the burrow openings being sealed within a few hours. Koford (1958) indicates that several authors have stated that one function of the mounds surrounding the entrance to the burrow system is to protect the burrow system from filling with water from shallow flooding (surface runoff) during cloudbursts. Vogel et al. (1973) have demonstrated that there is a flow of air through the burrow system and that mound shape and height have an influence on the amount and direction of flow. Airflow in the burrow system is from the dome-shaped mounds to the crater-shaped mounds and is accentuated by the fact that crater-shaped mounds are usually higher than dome-shaped mounds.

Koford (1958) reports that the average density of the entrances to the burrow systems is 20 to 40 per acre. He found an extreme density of 100 entrances per acre where the prairie dogs had been fed by tourists. He states that where food is abundant, burrows tend to be close together.

NESTING AND BEDDING REQUIREMENTS:

Site Preferences: Prairie dogs nest in the same burrow systems that are used for shelter. Sheets et al. (1971) describe a typical nest chamber as elliptical in shape, ranging from 12 to 18 in. at its widest point and approximately 10 in. high.

Materials: Sheets et al. (1971) report that a mat of dry grass approximately 2 in. thick covers the floor and extends partway up the walls. Grass in the nest lining includes buffalo grass (*Buchloe dactyloides*), prairie three-awn (*Aristida longiseta*), six-weeks fescue (*Festuca octoflora*), and cheat grass (*Bromus tectorum*). All linings contain prairie dog pellets and are infested with adult and immature forms of the flea *Ooisocrostis hirsutus*.

POPULATION STRUCTURE AND TRENDS:

No reports on the total number of black-tailed prairie dogs over its entire range are available, but there are some reports for individual states. These reports often state the number of acres of dog towns and must be converted to indicate number of individuals. Koford (1958) reports that "the breeding population of prairie dogs usually seems to be fewer than five per acre." Table D3 lists the states in which the black-tailed prairie dog occurs and indicates the total number of acres of dog towns, as reported by various authors. Koford (1958) indicates that population counts in an individual dog town will vary depending upon the season of the year. In the late spring and summer, the prairie dog's young are aboveground and increase the counts. He states that "counts of prairie dogs in winter or early spring, before the young come above ground, are important because they indicate the

size of the breeding population and the carrying capacity of the site to support prairie dogs." He further indicates that shooting, drought, floods, and poisoning campaigns greatly influence the population of prairie dogs and that the effects of even normal environmental changes on the populations are not understood. Smith (1967) reports that the ratio of adult females to adult males in Kansas was 59.41 per 100 individuals and that in yearlings the ratio was 62 females to 38 males per 100 individuals. However, he was unable to sex juveniles. Several authors (Clark 1973, Cheatheam 1973, Smith 1967, Torres 1973) have reported that the populations of prairie dogs in some states appear to be stable or increasing.

Responses to Management: Prairie dog control began early in the 1900's, and a widespread organized control program supervised by the Biological Survey commenced about 1919 (Koford 1958). A more effective poison was introduced in 1928, and in the 1930's more Federal funds and labor were used. In 1947, Compound 1080 was used as the principal chemical to "treat" 1,210,000 acres in Colorado (Koford 1958). Koford (1958) states that "the campaign against black-tailed prairie dogs was so effective that they are no longer considered a major agricultural problem. Now control is mainly 'cleaning up' old towns or small new colonies, and the acreage considered 'infested' is but a few percent of the area estimates 35 years ago." Recent authors report that the populations of black-tailed prairie dogs are increasing in several states (Linder 1973).

REPRODUCTION AND SURVIVAL:

Phenology: The time of breeding of the black-tailed prairie dog is later in the year in the northern part of its range than in the southern. Koford (1958) reports that pregnant females were taken in Oklahoma from late January to March and in Colorado from March to May. Smith (1967) indicates that the start of the breeding season may vary depending upon the severity of

the previous winter and the availability of food, but Koford (1958) reports that Foreman (1955) found that light, darkness, and cold did not change the timing of the reproductive cycle in the female prairie dog. Breeding occurs only once a year.

Family Structure: "The number of young produced in a prairie dog town depends on the size of litters, the number of mature females, and the proportion that bears young. Food, climate, and social factors affect these quantities" (Koford 1958). He also reports that the litter size for adult female prairie dogs averaged 5.0 in several studies and that the litters for yearling female prairie dogs averaged 3.3. He further indicates that 19 of 19 adult female prairie dogs that he caught had bred and that 18 of 27 yearling female prairie dogs had bred. The length of pregnancy is 28 to 32 days, and young are born in the burrows (Smith 1967, Koford 1958). "Small prairie dogs appear aboveground when about six weeks old and are weaned probably when seven to eight weeks of age" (Smith 1967).

Survival Rates: King (1955) reports that one population of 50 prairie dogs in 1948 decreased by 44 percent by the next year. Mortality was especially high in the young, with 36 percent dying the first year and 22 percent of the survivors dying the second year (22 marked individuals initially). He also found a much greater loss of males than females, apparently because of greater emigration of males (Koford 1958).

Longevity: Smith (1967) reports that prairie dogs in captivity live as long as eight years.

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Table D1

List of Animals That Occur In or Near Prairie Dog Towns

Taxon	Common Name	Source of Information
Antilocapra americana	Pronghorn	Koford 1958
Aquila chrysaetos	Golden eagle	Koford 1958
Asilidae	Robberflies	Smith 1967
Bufo cognatus	Great Plains toad	Smith 1967
Buteo jamaicensis	Red-tailed hawk	Koford 1958
Buteo lagopus	Rough-legged hawk	Koford 1958
Buteo regalis	Ferruginous hawk	Koford 1958
Calamospiza melanocorys	Lark bunting	Koford 1958
Calliphoridae	Blue Bottle flies	Smith 1967
Canis latrans	Coyote	Koford 1958
Carabidae	Ground beetles	Sheets 1970
Ceuthophilus spp.	Camel-backed cricket	Koford 1958
Chilopoda	Centipedes	Sheets 1970
Circus cyaneus	Marsh hawk	Koford 1958
Citellus tridecemlineatus	Thirteen-lined ground squirrel	Sheets 1970
Crotalus atrox	Western Diamondback rattlesnake	Koford 1958
Crotalus viridis oreganus	Northern Pacific rattlesnake	Koford 1958
Crotalus viridis viridis	Prairie rattlesnake	Koford 1958
Dipodomys ordi	Kangaroo rat	Koford 1958
Eleodes hispilabris	Terebrionid	Smith 1967
Eremophila alpestris	Horned lark	Koford 1958
Eupoda montana	Mountain plower	Koford 1958
Falco mexicanus	Prairie falcon	Koford 1958
Geomys spp.	Procket gophers	Koford 1958
Gryllidae	Cave crickets	Sheets 1970
Haliaeetus leucocephalus	Bald eagle	Smith 1967
Heterodon nasicus	Western Hognose snake	Smith 1967
Histeridae	Hister beetles	Sheets 1970
Holbrookia maculata	Lesser Earless lizard	Smith 1967
Latrodectus spp.	Black widow spiders	Sheets 1970
Lepus californicus	Black-tailed jackrabbit	Koford 1958
Lepus townsendi	White-tailed jackrabbit	Koford 1958
Lynx rufus	Bobcat	Koford 1958
Microtus ochrogaster	Prairie vole	Sheets 1970
Mus musculus	House mouse	Sheets 1970
Mustela nigripes	Black-footed ferret	Koford 1958
Onychomys leucogaster	Northern grasshopper mouse	Sheets 1970
Pedioecetes phasianellus	Sharp-tailed grouse	Koford 1958
Perognathus hispidus	Hispid pocket mouse	Smith 1967
Peromyscus maniculatus	Deer mouse	Sheets 1970
Phrynosoma cornutum	Texas horned lizard	Smith 1967

(Continued)

Table D1 (Concluded)

Taxon	Common Name	Source of Information
Pituophis melanoleucus	Pine snake	Smith 1967
Pogonomyrmex occidentalis	Harvester ant	Koford 1958
Reithrodontomys spp.	Harvest mice	Koford 1958
Rhynchophanes mccowni	McCown's longspur	Koford 1958
Scarabeidae	Dung beetles	Sheets 1970
Sceloporus undulatus	Eastern fence lizard	Smith 1967
Sistrurus catenatus	Massasanga	Smith 1967
Speotyto cunicularia	Burrowing owl	Koford 1958
Sphaeroceridae	Dung flies	Sheets 1970
Staphylinidae	Scavenger beetles	Sheets 1970
Sturnella neglecta	Meadowlark	Koford 1958
Sylvilagus andubonii	Desert cottontail	Koford 1958
Taxidea taxus	Badger	Koford 1958
Terebrionidae	Darkling beetles	Sheets 1970
Terrapene ornata	Ornate box turtle	Smith 1967
Thomomys spp.	Pocket gophers	Koford 1958
Tropidoclonion lineatum	Lined snake	Smith 1967
Zenaidura macroura	Mourning dove	Koford 1958

Table D2

Vegetation Eaten by Black-Tailed Prairie Dogs

Scientific Name	Common Name	Season* Consumed	Source** of Information
Agropyron smithii	Western wheatgrass	Sp	3
Agropyron spp.	Wheatgrass	Su,F,W,Sp	1,2
Amaranthus graecizans	White pigweed	Su	4
Andropogon saccharoides	Silver beardgrass	Sp	4
Aristida longiseta	Red three awn	Su,F,W	4
Artemisia spp.	Sage	W,Sp	1
Atriplex canescens	Four winged saltbush	W,Sp	1,3
Avena spp.	Oats	Su	1
Bouteloua gracilis	Blue grama	Su,F,W,Sp	3,4
Bouteloua spp.	Grama grass	Su,F,W	1,2
Buchloe dactyloides	Buffalo grass	Su,F,W,Sp	1,4
Bromus spp.	Bromegrass	Su,F,W,Sp	1,2
Chenopodium spp.	Goosefoot	W	1
Chrysothamnus nauseosus	Rabbitbrush	W	3
Cogswellia spp.	Biscuit-root	Sp	1
Euphorbia serpens	Spurge	Su	4
Eurotia lanata	Winterfat	W	3
Festuca spp.	Fescue grass	Su,F,W,Sp	1,2
Geranium carolinianum	Carolina geranium	Su	4
Helianthus spp.	Sunflower	Su,F,W,Sp	2
Hordeum jubatum	Foxtail barley	Su	4
Kochia scoparia	Summer cypress	Sp	3
Lepidum densiflorum	Peppergrass	Sp	4
Malvastrum coccineum	False mallow	Su,F,W,	1
Monolepis nuttalliana	Monolepis	Su	1
Opuntia polycantha	Prickley pear	W	3
Opuntia spp.	Prickley pear	Su,F,W,Sp	1,2,3,4
Oxalis europaea	Yellow wood sorrel	Su	4
Poa spp.	Blue grass	Su,F,W,Sp	1,2
Physaria didymocarpa	Double bladderpod	Su,Sp	1
Salsola kali	Russian thistle	Su,F,W,Sp	1,2,3,4
Sophia spp.	Sophia	W,Sp	1
Sphaeralcea coccinea	Scarlet globe mallow	Su,F,W,Sp	2,3
Polygonium aviculare	Knotweed	Su	3
Triticum spp.	Wheat	Su,F	1
Xanthium spp.	Cockleburs	Su,F,W,Sp	3,4

* Season abbreviations: Su = summer; F = fall; W = winter; and Sp = spring.

** Source of information codes: 1 = Kelso 1939; 2 = Martin et al. 1961; 3 = Koford 1958; and 4 = Smith 1967.

Table D3

Acres of Black-Tailed Prairie Dog Towns in the United States

State	Total Acres (X 1000)	Estimated Number of Individuals (X 1000)	Source of Information
Colorado	NA*	150.0	Torres 1973
Kansas	57.0	NA	Smith 1967
Montana	NA	NA	
Nebraska	NA	NA	
New Mexico	6,000	NA	Bailey 1931
North Dakota	NA	NA	
Oklahoma	NA	NA	
South Dakota	NA	NA	
Texas	77.5**	NA	Cheatheam 1973
Wyoming	132.5	NA	Clark 1973

* Not available.
** Portion of Texas, 65 northwestern counties.

APPENDIX E: NARRATIVE FOR SCALED QUAIL

FAMILY:

Scientific: Phasianidae (AOU 1957)

Common: Quails, partridges, and pheasants

SPECIES:

Scientific: _Callipepla squamata_ (AOU 1957)

Common: Scaled quail

LEGAL STATUS:

The scaled quail is protected by game laws in Texas, Oklahoma, New Mexico, Arizona, Colorado, and Kansas (Barnes et al. 1970). Campbell et al. (1973) state that their findings indicate that a season on scaled quail in New Mexico could safely be extended from late October to mid-January "without the slightest damage to the state's quail resource or of noticeably diminishing the following fall's crop of quail" and that "daily bag limits of 15-20 birds would not be harmful under present or foreseeable levels of hunting pressure."

VALUE POTENTIAL, POSITIVE:

The scaled quail is hunted as a game bird in several states (Barnes et al. 1970). Campbell et al. (1973) point out that in New Mexico, during 1963, the average expenditure per quail hunter was $135 and that this rate has probably increased annually. "Quail are important to a variety of people for a variety of reasons. Not only quail hunters but bird watchers, farmers, ranchers, professional wildlifers, zoologists, and conservationists in general are interested in the well-being of the quail resource. It is impossible to determine accurately the undoubtedly large total value of quail to the public because the greatest values are intangibles associated with recreation and its attendant social and individual benefits. There is, however, one definite measure that can be applied to obtain a partial estimate of the economic value of quail. It is the amount of money that hunters willingly spend in pursuing the sport of quail hunting" (Campbell et al. 1973).

These quail and their eggs serve as food for many predators, such as falcons, hawks, roadrunners, snakes, skunks, bobcats, coyotes, gila monsters, and owls (Bailey 1928, Bent 1932, Cambell et al. 1973).

DESCRIPTION:

Rea (1973) discusses four separate subspecies, C. s. caslamogastris, C. s. hargravei, C. s. pallida, and C. s. squamata, but for the purposes of this narrative only the species as a whole is considered. The weight ranges of adult males and adult females are 189.5-224 g and 174.3-194 g, respectively. Other measurements are given below:

	Adult male, mm	Adult female, mm
Wing (chord)	115.7-126.5	114.9-122.9
Tail	83.4-96.2	77.3-92.4
Tarsus	26.7-33.1	29.0-31.2
Bill	7.5-8.9	7.5-9.0

"Typically, in males, the side of the face is pearl gray except for a brownish ear patch, and the throat is clear white behind the lower mandible, blending lower down on the throat into a yellowish or buffy wash. In females, the side of the face is dirty gray by reason of a pattern of narrow black streaks on a ground color of gray or grayish white. The ground color of the throat is lighter than that of the face, but is also streaked with black, and does not have the yellowish or buffy wash typical of males. After a little practice, adult scaled quail can be sexed by the use of these characters with almost 100 percent accuracy...Many young males tend to resemble females" (Campbell et al. 1973). "The scaled quail is a decidedly terrestrial bird with very powerful legs, which it uses to advantage in the rather open desert growth in which it lives and where it can run very fast in the smooth open spaces among the desert plants. It prefers to escape by running rather than flying, but, if come upon suddenly and surprised, it rises with a whir of wings, flies a short distance, and scales down

into cover again, much after the manner of the bobwhite; it then starts running and cannot be easily flushed again. If in a flock, they sometimes follow a leader in Indian file, but more often they scatter in several directions and are soon lost to sight" (Bent 1932). Robbins et al. (1966) describe the scaled quail as "normally gregarious" and "usually found in flocks of up to 100 birds."

"The molt into the first winter plumage takes place during September and October. This is a complete molt, except for the two outer primaries on each wing, which are retained all through the first year. The molt begins on the back, breast, and flanks. Young birds are practically indistinguishable from adults during the first winter and spring except for the retained outer primaries. Both first-year and adult birds have a partial prenuptial molt early in spring, restricted mainly to the head and throat, and a complete postnuptial molt in August and September. Albinism occurs occasionally, and this species has been known to hybridize with Gambel's quail and with the bobwhite" (Bent 1932).

RANGE:

The scaled quail extends "from southern Arizona, northern New Mexico, eastern Colorado, southwestern Kansas, and western Oklahoma, south to Jalisco, Guanajunto, and Mexico" (AOU 1957). Hargrave (1939) states that archaeological evidence indicates that the scaled quail enjoyed a wider distribution in Arizona. During historic times the range of the species has been restricted to the southeastern portion of the state, but Hargrave (1939) indicates that this species did occur in the Little Colorado Valley and the San Francisco Mountain region near Flagstaff. He feels that "the retreat of extirpation of this species must have occurred between 1150 A.D., a date when Wupatki Pueblo is known to have been occupied, and 1880 A.D., when the country became settled" (Hargrave 1939).

HABITAT:

In a study in New Mexico, Campbell et al. (1973) describe as

"typical scaled quail habitat" two areas where the floral assemblage consists of black grama, tobosa as dominant grasses, and a number of shrubs and half-shrubs (e.g. mesquite, catclaw, whitethorn, and snakeweed). Robbins et al. (1966) describe the habitat of C. squamata as "dry semi-desert country."

FOOD HABITS:

"Scaled quail eat an interesting and impressive array of foods, but only a comparatively few kinds or types regularly make up the major portion of the foods used" (Campbell et al. 1973). In terms of percent of the total volume of foods eaten, Campbell et al. (1973) find that whitethorn, snakeweed, doveweed, and white-margin euphorbia account for 20.5, 11.3, 9.7, and 8.5 percent, respectively; insects accounted for 6.8 percent of the diet. Davis and Banks (1973), who analyzed the crops of 65 scaled quail collected during 1969 and 1970 in southeastern New Mexico, present their data in terms of a percentage of the total weight. Of the specimens collected in summer, they (Davis and Banks 1973) find that amaranth, doveweed, beetles, and unidentified insects account for 17.9, 9.7, 9.2, and 8.7 percent, respectively, of the total weight; during winter, they find the preferences to shift to mesquite (25.0 percent), euphorbia (15.5 percent), doveweed (10.7 percent), and snakeweed (10.5 percent). "Changes in diet associated with changing seasons indicate the need for a variety of sources of food. Since seeds of mesquite and snakeweed represent approximately 36 percent of the winter diet, reduction or removal of these species in a brush control program could have a negative effect on scaled quail" (Davis and Banks 1973).

"The scaled quail apparently eats more insect food than any of the other quails, more than 29 percent, as against 70 percent of vegetable matter. Of this vegetable matter, over 50 percent is weed seeds, among which are thistle, pigweed, and bindweed, a troublesome weed that often throttles other plants. Dasylirion seeds almost entirely filled six stomaches examined. Wild fruit,

such as prickly pear and the succulent parts of desert plants, together with its larger percent of insect food, doubtlessly help it to live with a minimum amount of water. Its insect food includes grasshoppers, ants, beetles--among them leaf chafers and cucumber beetles--and weevils, such as the clover pest and scale insects (several hundred in one stomach) that feed on the roots of plants" (Bailey 1928).

Campbell (1960) pointed out that scaled quail do not need free water to live successfully in New Mexico, but they do drink it when it is available and, in fall and winter, can be found around windmills and other water sources.

SHELTER REQUIREMENTS:

Campbell et al. (1973) stated that scaled quail prefer the flora of the desert grassland association (see discussion under HABITAT). The species may spend the fall at somewhat higher elevations (Bailey 1928). Simmons (1925) reports that C. squamata "shuns timbered country" but likes that which is "characteristic of the barren plateaus in the mountainous districts of western Texas, usually where the soil is fine, loose, and sandy; broad, dry, arid washes, gulches, and semi-barren plateaus of the hills where hard ground is covered with a few throny bushes, scattered scrub oak, chaparral, mesquite, sagebrush, and different species of cactus; chaparral and mesquite country, generally in the vicinity of water, but sometimes miles from any stream or pond."

NESTING AND BEDDING REQUIREMENTS:

The nests of the scaled quail are always on the ground in a slight hollow scratched by the bird in the sand (Bendire 1892). Bent (1932) describes a scaled quail nest that he observed in Arizona on the ground as follows: "The nest was well concealed under a tuft of grass surrounding a tiny mesquite; the grass was well arched over it, and the hollow in the ground was lined with dry grass and a few feathers. It held 14 fresh eggs." Nests found by others have been similarly located under the shelter of some low

bush, sagebush, creosote bush, mesquite, catclaw, cactus, or yucca, rarely in an open situation among rocks or under a fallen bush. Simmons (1925) says that in Texas the nest is rarely placed in a meadow or grainfield. The nest is lined with whatever kind of dry grass is available. In quoting F. C. Willard's unpublished notes, Bent (1932) states that "most of the nesting occurs during the months of June and July. I am inclined to believe that this is because the rainy season in Arizona commences, under normal conditions, early in June. Thereafter, there are more or less heavy showers nearly every day. This assures a supply of drinking water within easy reach of the newly hatched young. The nests are usually placed under some tussock of mixed dry and green grass. In the vicinity of gardens, they sometimes build under tomato vines. Where a haystack is available, they are quite likely to work out a hollow near the bottom and lay their eggs there much after the manner of the domestic hen. It is not at all unusual for two scaled quail to lay their eggs in the same nest, if the presence of two distinct types of eggs in the same nest can be considered as evidence. In several instances, I have had nests under observation (which did not yet hold complete clutches), and in three of these instances, eggs were deposited at the rate of two per day, quite positive proof that two birds were using the same nest."

RITUAL REQUIREMENTS:

The scaled quail is nonmigratory (Bent 1932), but in the fall it may be found at higher elevations than during the nesting season (Bailey 1928). "The entire life of the scaled quail is spent in the environment to which it is so well adapted, but in the fall it is sometimes found a few hundred feet higher than in the nesting season. When the young are raised these delightful little cottontops go about in small flocks, visiting water holes and river bottoms. Picking up insects, seeds, and berries as they go, they wander through brushy arroyos, over juniper-clad foothills, cactus flats, and sagebrush or mesquite plains, calling to each other with a nasal _pay-cos, pay-cos,_ which by long association comes to take

on the charm attaching both to the gentle-eyed birds themselves and to the fascinating arid land in which they make their homes" (Bailey 1928).

In discussing the sounds made by the scaled quail, Bendire (1892) states that "their call note sounds something like a lengthened chip-churr, chip-churr; the same, only more rapidly repeated, is also given when alarmed, and a guttural oom-oom-oom is uttered when worried or chased by a hawk. The young utter a plaintive peep-peep, very much like young chickens."

POPULATION STRUCTURE:

Robbins et al. (1966) state that these birds are "usually common," but that the "population fluctuates from year to year." In discussing the status of the scaled quail in Arizona, Phillips et al. (1964) state that it "...is chiefly an inhabitant of grassland, and as a result of the destruction of the grass, it has been greatly reduced or locally exterminated in many parts of the state. On the other hand, the Gambel's quail increases in these same areas as the grass is replaced by mesquite bushes and cholla cactus."

Campbell et al. (1973) report average scaled quail densities of 21.9 and 29.2 birds per square mile in their two New Mexico study areas during an observation period of seven years in the 1960's.

REPRODUCTION AND SURVIVAL:

"The scaled quail lays from 9 to 16 eggs, rarely more, and usually from 12 to 14" (Bent 1932). The young are hatched from April to September with peak periods being July and August (Campbell et al. 1973). The period of incubation is about 21 days, and two and even three broods are occasionally raised in a season (Bendire 1892).

The eggs of *C. squamata* are described by Bent (1932) as "...ovate or short ovate in shape and usually quite pointed. The shell is thick and smooth, with little if any gloss. The ground color varies from dull white to creamy white. Some few eggs are thickly, or even heavily speckled with very small spots or minute dots of

dull, light browns, 'sayal brown' to pale 'cinnamon-bull.' Most of the eggs are sparingly marked with similar spots. Some are nearly or quite immaculate. ...The measurements of 57 eggs average 32.6 by 25.2 mm; the eggs showing the four extremes measure 35.8 by 26, 34 by 27, 30 by 24.5, and 31.5 by 23.5 mm."

In two study areas in New Mexico, based on 3500 live-trapped and banded birds, Campbell et al. (1973) found that 95.5 and 92.6 percent of the birds died within the first year, but that 0.1 and 0.3 percent of the birds lived six years.

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APPENDIX F: NARRATIVE FOR BOBCAT

FAMILY:

Scientific: Felidae (Jones et al. 1975)

Common: Cats

SPECIES:

Scientific: *Felis rufus* (Jones et al. 1975)

Common: Bobcat

LEGAL STATUS:

"Under Colorado law the bobcat is regarded as a 'non-game mammal,' subject to licensed hunting throughout the year" (Armstrong 1972). Not listed by Barnes et al. (1970) as a game animal in any state.

VALUE POTENTIAL, POSITIVE:

"Bobcats are often trapped for the pelt alone, which produces strong leather but rather brittle, perishable fur. ...The fur is used for trimming coats of cloth or of other animals' fur, and for women's jackets. While most persons consider that the flesh of any cat is not fit for consumption, some hunters have tried bobcat meat and recommend it with enthusiasm. They claim that it is sweet and tender" (Cahalane 1961). "Where bobcats are common, hunting them with dogs furnishes considerable sport. ...As predators and scavengers, bobcats play an important role in the wildlife community" (Schwartz and Schwartz 1959). "Depending largely on smaller creatures, the cats help to keep down excessive numbers of snowshoe hares, cottontails, porcupines, and some of the smaller rodents" (Cahalane 1961).

In discussing the aesthetic qualities of the species in Louisiana, Lowery (1974) states that "this species is one of the more handsome constituents of our state's mammal fauna. Its lithe, graceful body and its beautifully marked facial pattern combine to give it a great physical character, and its skill as a hunter inspires admiration on the part of those who love the out-of-doors and the denizens of our forest, large and small." "Unless causing heavy

damage to man's interest, bobcats should be tolerated and regarded as part of our vanishing wilderness" (Schwartz and Schwartz 1959).

"Any meat-eater as large and well-armed as the wildcat may offend mankind, at least occasionally, by killing domestic or wild game creatures. Sometimes, it has been known to kill domestic sheep and even calves. During two evenings, one wildcat killed three ewes and nine lambs. Chickens and turkeys are easy game if it wishes to take the risk of entering poultry yards" (Cahalane 1961). Bailey (1931) states that some bobcats not only kill domestic livestock (principally sheep) and fowl, but that they may not consume all that they kill. "It often takes more than it needs, and unless food is scarce it seldom returns to old kills, even though it may have covered the remains with leaves" (Lowery 1974). "Bounties for the wildcat's scalp were offered as early as 1727 by Massachusetts, where the reward was thirty shillings for each adult. Much later, in 1903, the state reestablished the bounty at five dollars, which was raised to ten dollars in 1925. Many other states offer smaller amounts" (Cahalane 1961).

DESCRIPTION:

Although Armstrong (1972) recognizes three subspecies of *F. rufus*, (*F. r. pallescens*, *F. r. baileyi*, and *F. r. rufus*,) as occurring in Colorado, and Hall and Kelson (1959) indicate the presence of both *F. r. baileyi* and *F. r. pallescens* in that state, this narrative treats the characteristics that apply to the species, *F. rufus*, as a whole.

The bobcat is similar to the lynx (*F. lynx*) but smaller. Its feet are considerably smaller, and its ear ruffs are small and sparse or even absent. The upper parts are pale yellowish brown to reddish brown mixed with gray and brownish or black, becoming whitish spotted with black on the under parts. The underside of the tail tip is white, whereas the tail of the lynx is completely ringed with black. Its total length usually varies from 32 to 42 in., and its height at the shoulder and weight range from

14 to 15 in. and 15 to 25 lb, respectively. The maximum known weight is 39.75 lb (Cahalane 1961).

RANGE:

The bobcat ranges from southern Canada to southern Mexico and from the Atlantic Ocean to the Pacific Ocean (Hall and Kelson 1959). "...In recent years it has been extirpated from much of the central United States" (Schwartz and Schwartz 1959).

HABITAT:

The bobcat "...is not particular about its home but is found in the cold woodlands of the northern states and in the hot humid swamps of the South. I have seen tracks on the desert sands in southern Arizona and in the mountain ranges far above. It is perfectly at home on the central plains provided there are rocky "breaks" or canyons, or a good fringe of trees along a water course. Cutover lands are quite acceptable. In fact, it prefers variegated country with plenty of openings and brushy patches to solid primeval forest, because the small animals, which form the bulk of its diet, are more plentiful there. During the last thirty or forty years, the Minnesota bobcat has extended its range one hundred to two hundred miles north as lumbering opened up the country. Extreme cold is the only climate that it will not take, and it is not found far north of the southern boundary of Canada. The boreal forests are left to the lynx" (Cahalane 1961). "The bobcat lives in heavy forest cover, preferably second growth timber with much underbrush, broken with cliffs and clearings, and in timbered swamps" (Schwartz and Schwartz 1959). "Although a good climber, the bobcat is not an arboreal animal by any means. It goes up trees after occasional tempting food, such as a brood of young flickers, woodpeckers, or other high-nesting birds that advertise their presence by noisy squabbles. Most food is gleaned from the ground, and the trees are used only occasionally, for resting and for refuge. ...Like other fluffy-haired cats, the bobcat is not fond of water. Melting snow, which fills the northern swamps with spring runoff, drives it to the ridges and hills. To cross a stream, it will go out of its way

to find a log "bridge" rather than wade through a few inches of water. It has been known to swim at times, however, quite voluntarily, as well as to escape from trailing dogs" (Cahalane 1961).

FOOD HABITS:

Martin et al. (1951) consider both the lynx (F. lynx) and the bobcat in discussing food habits. They state that birds, rabbits, squirrels, other small mammals, and occasionally deer are taken as prey.

"Cottontail and snowshoe hares are stalked through the thickets and swamps. Moving slowly, the bobcat hunts by sight rather than scent. Tracks are followed only incidentally, and then for but a short distance. Carefully it searches through thickets and similar hiding places, creeping up to logs and the crest of knolls, and looking over the area ahead before proceeding. Its keen eyes examine every detail of the woods and catch the slightest movements. Sometimes it steals close to its prey and leaps upon them while they are asleep or resting in their forms. At other times it watches patiently for hours from the vantage of a hummock, a stump, or a prostrate log. When game approaches, it flattens, then rushes suddenly forward. At other times, it ambushes the animal on its trail. Leaps of seven or eight feet are not at all extraordinary. It is said that the bobcat can cover ten feet at a single bound. If it cannot leap upon or overtake its intended prey after a brief chase, it gives up and resumes the search elsewhere. In the desert, it catches woodrats while they are away from the safety of their houses. Unlike the wild dogs, the bobcat does not break into dwellings of its prey. Its closest attempt to house breaking is on the very rare occasions that it claws (ineffectually) at the rotten logs where its nose determines that small rodents have been hiding. Other foods are mice, tree squirrels, chipmunks, ground squirrels, marmots or woodchucks, shrews, and muskrats. Although commonly accused of killing birds..., the bobcat seldom goes into the trees to hunt. Ground-nesting birds, such as grouse, are

avidly seized at every opportunity. Carrion is eaten, and sometimes green grass and foliage of trees and shrubs are taken as a tonic. Miscellaneous appetizers, including turtles, dead fish, and insects, are picked up here and there. Bobcats kill and eat porcupines. It has been assumed that only foolhardy youngsters that are hard pressed for food will attack this quill-coated prey. However, a study of bobcat diet in Minnesota revealed that porcupine flesh was the third most numerous food and was present in ten out of fifty stomachs. The quills do not seem to cause any great injury once they are swallowed, even though they work through the walls of the intestines. However, some cats die from the effects of too many quills in the mouth, face, and neck. Bobcats have been seen to meet skunks and pay little attention to them, but they have also been known to eat them occasionally" (Cahalane 1961).

In describing the method by which bobcat attack adult deer, Cahalane (1961) states that "they steal up, leap on the deer, and bite into the jugular vein high on the throat. Frequently the stricken animal drops within a couple of leaps, and the cat proceeds to feed on the warm flesh. In one instance, a struggle between a buck deer and a bobcat was waged for between three and five hours. A human interloper then frightened away the bobcat. Deep snow handicaps the cat as much as it does the deer. The cat must make its assault in about two jumps with such speed that the deer is caught by surprise. A successful hunt seems to depend more on the approach and efficiency of attack than on the condition of the victim, although, of course, a sick deer would be less wary than one in good health."

"A study of the food habits of 41 bobcats in Missouri showed the following foods and their percentages by volume: rabbits 67.0; mice, rats, and shrews 0.7; squirrels 9.9; deer 8.6 (some of which is probably carrion); opossums 1.9; domestic cats 1.7; wild turkeys 7.9; quail 1.7; undetermined meat 0.5; and grasses 0.1. This agrees with the foods of bobcats in other parts of the range where

the diet consists primarily of small mammals supplemented by various birds. Deer are eaten at times, but most of this source of food is doubtless carrion. Bobcats gorge when food is plentiful and may not feed again for several days. They seldom return to eat from an old kill unless food is scarce. They waste considerable meat and may kill more than they eat. They use their feet to bury any surplus food under snow or leaves" (Schwartz and Schwartz 1959). "Bobcats are also believed to kill bighorns and young elk on some occasions, but the toll is not known" (Cahalane 1961).

SHELTER REQUIREMENTS:

"A bobcat den may be located under a log, within a fallen hollow log, or within a standing hollow tree. A nest in a dense thicket may occasionally serve as a home" (Hoffmeister and Mohr 1972). "During most of the year, a fresh rest shelter, such as a thicket, standing or fallen hollow tree, or a recess in a rocky cliff, is used each day. In the breeding season, similar but usually more inaccessible places are chosen for a den" (Schwartz and Schwartz 1959). When fleeing an enemy (e.g. domestic dogs) the bobcat will often seek temporary shelter in a rock den or in a large tree (Cahalane 1961). He also states that a bobcat, after a night of hunting, may find it necessary to "hole up for the day" if far from his starting point; such shelter may be "under a windfall, in a hollow log, in a hollow tree standing up, or even in a thicket." For the birth of her kittens, a mother bobcat will likely choose as a den a spot in a rocky ledge or cliff, but she may even choose a hollow stump or a fallen log (Cahalane 1961). "Bobcats have a very strong odor, and their dens also develop this characteristic smell" (Schwartz and Schwartz 1959).

NESTING AND BEDDING REQUIREMENTS:

"The nest is made of dried leaves and soft moss" (Schwartz and Schwartz 1959).

RITUAL REQUIREMENTS:

Bobcats usually breed during the early winter. One male may breed with several females if they are free or can be taken from their

current mates (Cahalane 1961). "Bobcats are generally quiet but may give high-pitched screams or low growls. During the breeding season, when they are more vociferous than at other times, their caterwauling consists of squalls, howls, meows, and yowls..." (Schwartz and Schwartz 1959). Cahalane (1961) further describes their vocalizing during mating season as follows: "At this time, the animals outscream themselves. They squall and yowl like overgrown alley cats. They have a varied repertoire with astounding range and volume. As soon as a male has achieved results from a successful serenade, he goes on his solitary way to further vocal and amorous triumphs, that is, if he can find another female that is free or can be taken away from her current mate." Hoffmeister and Mohr (1972) describe the sounds as "...a weird and eerie series of yowls and meows somewhat like that of the common house cat, but louder, huskier, and infinitely more mysterious."

Bailey (1974) conducted a study in southeastern Idaho in which radio tracking was used to determine home range or territory of bobcats. He found that "female ranges varied from 9.1 to 45.3 km^2 and male ranges from 6.5-107.0 km^2 in size." "...adult bobcats scent marked with feces, urine, scrapes, and oral glands." He reported the least overlap in female-female territories and the greatest overlap in male-female territories, and that some of the overlap among these territories was "...probably an artifact of the abstract manner by which home range boundaries were delineated." According to Ewer (1968), territoriality seemed more pronounced among female than among male bobcats.

POPULATION STRUCTURE:

Population figures for the entire range of the bobcat are difficult to obtain. In Minnesota, the population has been estimated at 1800-4000 (Cahalane 1961). A 1934 estimate of bobcat density in Missouri is one bobcat to 10-12 square miles of range (Schwartz and Schwartz 1959). Lowery (1974), in referring to the abundance of the bobcat in Louisiana, states that "all through the vast

hardwood bottomlands along the Mississippi River from the Arkansas line southward through the Atchafalaya Basin and the floodplain of the Mississippi River, as well as in forested areas adjacent to other river systems, the bobcat maintains itself in appreciable numbers."

REPRODUCTION AND SURVIVAL:

Breeding begins in January and may possibly occur as late as June (Schwartz and Schwartz 1959). After a gestation period of 50-70 days, usually two or three (possible extremes are one and five) kittens are born (Cahalane 1961, Schwartz and Schwartz 1959). "Most litters are born in early April or late May, but some authorities think a second litter may occur in late summer" (Schwartz and Schwartz 1959). Kittens are born with spotted fur and sharp claws. At birth they weight 12 oz and have a length of 10 in. The eyes remain closed for 9-11 days. Weaning occurs at the age of two months, but the kittens usually remain with the mother until the fall of the year or even through the first winter (Cahalane 1961, Schwartz and Schwartz 1959). "The rate of development of the young bobcat is similar to that of the young of the domestic cat" (Hoffmeister and Mohr 1972).

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APPENDIX G: NARRATIVE FOR MOUNTAIN LION

FAMILY:

Scientific: Felidae (Jones et al. 1975)

Common: Cats

SUBSPECIES:

Scientific: _Felis concolor hippolestes_ (Hall and Kelson 1959)

Common: Mountain lion (Hall and Kelson 1959, Jones et al. 1975); cougar, panther, puma (Cahalane 1961); Rocky Mountain cougar (Bailey 1931); Rocky Mountain puma (Young and Goldman 1946)

LEGAL STATUS:

The mountain lion is protected by game laws in Utah (Barnes et al. 1970) and Colorado (Armstrong 1972).

VALUE POTENTIAL, POSITIVE:

Mountain lions serve as predators, thus improving the lot of mule deer and other animals by reducing excess numbers (especially in areas not subjected to hunting pressures) and removing poorer quality animals from the herds (Armstrong 1972, Cahalane 1961). Cougar hunting is a popular pastime in the various western states of its range (Hamilton 1939). Some captured as kittens are relatively easy to handle even as pets (Cahalane 1961). The pelt of the mountain lion is worth little as fur, and although the hide makes tough leather, the numbers taken are too few to make it of economic importance (Eadie 1954). Young and Goldman (1946) discuss the animal as a food source, and they include reports of the early settlers of the New World and the Indians eating its flesh (e.g. Catesby 1743, Hariot 1587) and finding it quite palatable. Both Young and Goldman (1946) and Eadie (1954) include more current reports on human consumption of mountain lion meat.

The Indians of Baja California, revered the cougar as "...a God who provided them with much of their food" (i.e. cougar kills) (Cahalane 1961). Jenkins (1971) feels that "...the cougar (_Felis concolor_) has high aesthetic value. ...All of the wildcats are

much admired by naturalists and ecologists,...because they add to the 'wilderness' of the environment."

VALUE POTENTIAL, NEGATIVE:

Although the mountain lion normally preys on smaller animals, they will cause destruction to livestock (cattle, horses, sheep, etc.) and fowl (Bailey 1931). Bounties were offered for these animals in Colorado from 1957 to 1965 (Armstrong 1972) and in other states (Cahalane 1961).

Mountain lions are also reported to rarely kill humans. Cahalane (1961) states that rare attacks against humans are committed by very old animals unable to kill their usual prey or by rabid animals, but he does describe the documented case of a young healthy female mountain lion killing a 14-year-old boy in the State of Washington in 1924.

DESCRIPTION:

Cahalane's (1961) description of the species F. concolor is as follows: "A very large, slender cat with small head and long, heavy, cylindrical tail; rounded ears, which are not tufted. Fur soft, uniformly dull yellowish brown, reddish brown, or gray, paler on the flanks and shoulders and merging into dull whitish on the under parts; tail tipped with dark brown to blackish. Total length, 6 to 8-1/2 feet, or more; height at shoulder, 26 to 30 inches; weight, generally 100 to 175 pounds. Females weigh about 40 percent less than males. ...Great size and unspotted fur; the only other North American cat of comparable size, the jaguar, has a heavily-spotted leopardlike coat."

Young and Goldman (1946) describe F. c. hippolestes as "maximum size, perhaps the largest, of all the subspecies, general color rather pale, pelage long, full and soft, skull very large and elongated, and dentition light."

RANGE:

The range of F. c. hippolestes is from North Dakota to the Oklahoma panhandle and northern New Mexico and from the North

Dakota-Minnesota boundary to Idaho and eastern Nevada (Hall and Kelson 1959).

HABITAT:

Of the species, F. concolor, Cahalane (1961) reports that "cougars have a wider distribution than any other American mammal. They are found on plains near sea level, on high mountains, in the foggy, chilly rainbelt of the forested northwest, on the burning sands, and deep in the dense growth of the tropics."

In Colorado the species formerly ranged throughout the state in various habitat conditions, but in the eastern part of the state it was probably "...restricted to riparian situations or rocky habitats" (Armstrong 1972). In discussing the areas preferred by F. concolor in Colorado, Young and Goldman (1946) state that "in early times the puma was common from the crest of the Rockies westward to the Utah state line. It occurred occasionally eastward from the Rocky Mountains well out onto the plains, particularly where brushy water courses afforded ample cover." They also mention earlier reports of the species "not being uncommon along the banks and bottom of the Arkansas River..." Armstrong (1972) reports that F. c. hippolestes is "...presently restricted to the western three-fifths of the state and most abundant at moderate elevations on the western slope."

FOOD HABITS:

"Its food is almost entirely flesh. Besides domestic animals, it feeds on deer, squirrels, rabbits, porcupines, gophers, and rats" (Martin et al. 1951). "Most observers concur in the belief that an adult mountain lion requires about a deer a week on the average to maintain itself. The actual figure may be larger or smaller, but there is no evidence that such a toll on deer herds represents a serious drain in wild areas where both are present" (Cahalane 1961). Young and Goldman (1946) report that the cougars have eaten mountain goats, mountain sheep, horses, elk, hogs, rabbits, ground squirrels, beaver, mice, porcupine, coyotes, martens, and

carrion. They conclude that "from all of the foregoing it becomes evident that although the puma takes a wide range of foods, both wild and domestic, nevertheless its favorite food, when available, is unquestionably the deer, its extensive range attests to this fact, and in general it may be said the puma 'goes with the deer.'" Extravagant claims are made that a cougar will kill about 300 of its favorite prey each year. Careful estimates by naturalists run from 35 to 100 (Cahalane 1961). Young and Goldman (1946) even describe a rare occurrence of cannibalism in mountain lions, and Cahalane (1961) reports of a father lion eating his young after the death of his mate.

"The usual method of hunting is to stalk silently its prey until it is within a few feet of it; then the lion bounds upon its back, gripping the shoulders with the front claws and fastening the hind claws in the flanks. It then kills by biting the animal through the back of the neck" (Musgrave 1926). "An average of two out of three deer manage to avoid the final spring of the enemy and get clear away. If the cougar misses, and the quarry runs, she makes no more than a few jumps in pursuit. She knows that in a foot race she has no chance to overtake a deer" (Cahalane 1961). After a kill, a mountain lion drags its prey under a bush or tree before eating any part of it. This includes large animals (e.g. livestock) weighing 800-900 lb or more. According to Musgrove (1926), large deer and large calves may even be carried off. He also states that a lion will cover a carcass with leaves, sticks, and rocks after gorging itself, and "...retire to some nearby spot to 'sleep it off.'" He further explains that this animal is "...rather fastidious about food and rarely eats anything but untainted meat..." but that he has observed it eating carrion in a few instances. Young and Goldman (1946) report that the mountain lion is capable of existing without water for long periods of time.

SHELTER REQUIREMENTS:

Young and Goldman (1946) state that "the den or lair where the

young are born often is located in some rocky cavern on a mountain side, under an uprooted tree, or in some other nook protected from the elements. On the other hand, where the topography is not rough but has heavy underbrush, the lair is in a dense thicket."

NESTING AND BEDDING REQUIREMENTS:

"As with the wolf and coyote, no bedding is prepared" (Young and Goldman 1946).

RITUAL REQUIREMENTS:

Young and Goldman (1946) report that aside from the regular menstrual periods, the female comes into heat almost immediately after the young are born; the period of heat approximates nine days. As many as four or five males will follow the female, fighting over her until the victor obtains the first breeding privilege. The first breeding may be followed by union with other males. Cahalane (1961) indicates that when the female is in heat, the male and female live together, and the male will fatally maul an interloper.

Mountain lions will occasionally engage in play according to Cahalane (1961), who describes the eyewitness report of an employee of the National Park Service in Utah, and Young and Goldman (1946), who report several observations.

"Every puma has an extensive territory through which it roams on a roughly circular path, which may be 100 miles in circumference, thus leaving each hunting ground undisturbed for days at a time" (Morris 1965).

POPULATION STRUCTURE:

Population estimates of the subspecies _F. c. hippolestes_ are difficult to obtain. Bailey (1931) states that Forest Service officials reported the subspecies as "abundant" in Carson National Forest in 1910.

REPRODUCTION AND SURVIVAL:

The animals are at least two, and probably three, years old when they begin breeding. The mating period is short, and the two cats

"...separate to meet again only by chance, and then probably with a tinge of hostility" (Young and Goldman 1946). The cougar seems to breed once every two to three years, having from one to six kittens, which may be born at any time of month of the year (Young and Goldman 1946).

The gestation period is 91-96 days. The kittens are blind for eight to nine days. They are nourished by nursing until six or seven weeks old, when they begin eating meat and chewing bones. At the age of three or four months, they are weaned. They remain with the mother for one to two years. (Cahalane 1961, Palmer 1949, Young and Goldman 1946). "The cubs are at first heavily marked with black spots, but these fade as the animals grow older, so that adult pumas are plain greyish brown over the whole body" (Morris 1965).

Panthers live 15-18 years in the wild (Young and Goldman 1946).

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APPENDIX H: NARRATIVE FOR COYOTE

FAMILY:

Scientific: Canidae (Jones et al. 1975)

Common: Canines, dogs

SPECIES:

Scientific: Canis latrans (Jones et al. 1975)

Common: Coyote

LEGAL STATUS:

The coyote is hunted as a game animal in much of western and central North America with no seasonal restrictions. Until 1970, a number of states paid bounties on coyote scalps with ears. Some groups (e.g. Defenders of the Coyote), however, oppose any form of control placed on the coyote and want the animal placed on a protected list (McLeran 1974).

VALUE POTENTIAL, POSITIVE:

This species is one of the most potent checks on rodent populations. Its activities minimize agricultural damage by rodents and lessen the danger of epizootics. The fur of the coyote is durable and valuable (Cahalane 1961).

VALUE POTENTIAL, NEGATIVE:

The principal argument against the coyote is the alleged damage by these predators to game animals and livestock. Food habit surveys have indicated that actual damage rendered to cervid game populations is negligible (Murie 1935). Handicapped, aged, and a minority of healthy coyotes living near domestic herds are likely to prey regularly on them. These animals "...cause a serious annual loss to the sheep industry...," and they also kill "...a considerable number of turkeys and other poultry and on rather rare occasions ...calves" (Cahalane 1961). Game biologists and predator control personnel contend that when livestock depredations occur in a given area, probably one or two "outlaw" coyotes are to blame--not the entire coyote population in that area. "Controversy surrounding the coyote ranges from a desire for complete

protection to cries for total extermination" (McLeran 1974).

DESCRIPTION:

"Resembling a dog of the collie type, but with shorter body and rough, grizzled coat. Fur thick, fairly long and coarse. Upper parts grizzled grayish or tawny, black and yellowish, under parts whitish, tail tipped with black. Total length, 42 to 50 inches; height at shoulder, 18 to 21 inches; weight, 20 to 30 pounds and rarely to 60 pounds" (Cahalane 1961).

RANGE:

Western and central North America; from Costa Rica north throughout Alaska and the lower Mackenzie, and from the Pacific Ocean eastward into eastern Arkansas, Missouri, western Ohio, Michigan, eastern Ontario and Keewatin, Northwest Territories. Sporadic in every eastern state and Quebec (Cahalane 1961).

"Although coyotes are generally assumed to be territorial, one of their most prominent traits is their mobility. They cannot be described as strictly nomadic, however, for most tend to settle in a particular area or at least confine their wanderings to a limited range. Depending upon local conditions, individual coyotes apparently adjust their ranges, occupying smaller areas when food and shelter are more abundant" (McMahan 1975).

HABITAT:

The coyote inhabits the open plains, deserts, and prairies of North America (Morris 1965). Because of their hardiness and adaptability, the coyotes have frequently responded to habitat modifications (due to logging, fires, agriculture, and urbanization) and animal control programs by extending their range (Richens and Hugie 1974). Movement patterns of the coyote seem to suggest that there is no barrier to coyote spread except that of suitable habitat--principally adequate food (Richens and Hugie 1974). The criterion for a suitable coyote habitat is quite variable. Since open or semiopen country is preferred, the coyote has expanded its range into forested areas that have been opened up (Young and Jackson

1951). Clearing of northeastern forests probably provided suitable habitat for these canines to extend their range eastward (Paradiso 1969). However, coyotes were also found in brushy areas and second-growth forests in the northeast (Cronan 1962, Jackson 1961). In Maine, wilderness and forestland, as well as areas characterized by an interspersion of cultivated fields, orchards, and woods, are occupied by the coyote (Richens and Hugie 1974). The major range in New York is in the forested Adirondack Mountains; in Ontario and Quebec, coyotes occupy swamplands, urban parks, wilderness, and farmland, the latter supporting the highest densities (Richens and Hugie 1974, Ontario Department of Lands and Forests 1972).

FOOD HABITS:

The coyote is almost entirely carnivorous, feeding on jack rabbits, squirrels, and other rodents. Its diet may also consist of fruit and vegetable matter, as well as many forms of meat, fish, and fowl (including carrion) (Martin et al. 1951). Normally the coyote is a night feeder, but when food is scarce, it will travel for great distances during both day and night to search for food (Bailey 1931). Sperry (1941) discusses the analysis of the contents of 8339 stomachs of adult coyotes collected during all periods of the year in western and central states. He found that rabbits, carrion, rodents, and livestock comprised 33, 25, 18, and 13.5 percent, respectively, of the volume of the stomach contents. The remaining 10.5 percent included deer, birds, insects, vegetable matter, and "other animal matter" (i.e. cold-blooded vertebrates and a trace of invertebrates other than insects). In another study (Murie 1940), 5086 coyote droppings were collected from the first of April to mid-November during 1936, 1937, and 1938 in Yellowstone National Park, Wyoming. Seventy food and thirty-six nonfood items were identified. An analysis of the number of occurrences (not by volume or by weight) of these various items was made. The items occurring the greatest number of times in the droppings were field mice, pocket gophers, and adult elk (mainly carrion) with percentages of 34, 22, and 13 percent,

respectively. Murie (1935) examined 64 coyote stomachs and 714 droppings from Jackson Hole, Wyoming. He tabulated both carrion and noncarrion items in terms of number of occurrences and performed "economic evaluation" on the noncarrion portion based on 24 species of birds and mammals found. He determined that 70.29 percent of the time the coyote had "economically beneficial food habits" (i.e. removing those rodents or other vertebrates that may cause harm to man).

Nellis and Keith (1976) performed a volumetric analysis of the contents of coyote stomachs collected in central Alberta over a five-year period. They found that large mammals (mostly carrion from swine and cattle) and rodents comprised 44 and 39 percent of the volume, respectively. A number of studies in northern and eastern North America (Coppinger et al. 1973, DuPuy 1971, Ozoga and Harger 1966, Richens and Hugie 1974) showed no preference for any one food item. Deer, rodents, insects, fruit, and vegetation are all likely food items.

SHELTER REQUIREMENTS:

"When the pair first set up housekeeping, they occupy one or the other's den, or find or build another for the coming family... Usually they settle in the hollow base of a tree in a forest, a hollow log, a cave in a cliff or mountainside, a space in a pile of rocks in the open, or a burrow on the prairie or under the rim of an arroyo. The animals dig readily with their clawed feet if the soil is fairly loose. They excavate a tunnel between one and two feet in diameter and five to thirty feet long. Labor is often conserved by enlarging or remodeling the burrow of a badger, skunk, or fox. Generally there are several branches. The dirt is pushed back to the entrance and tossed out in a low, fan-shaped heap. At the end of the burrow is the den, a chamber a little larger than the passageways, whose roof may be anywhere from one to six feet below the ground surface. ...The entire burrow is kept clean. It is sometimes ventilated by a hole in the ceiling of the den, and

droppings are always deposited outside" (Cahalane 1961). Bekoff and Diamond (1976) observed that den digging activities of a pair of captive coyotes began in late December and continued until early March, with the female doing most of the work.

"During the daytime they generally hide in gulches or find some cover of brush or weeds in which to sleep after a full meal, but if their meals have been scanty, they travel far and wide during both day and night in search of food" (Bailey 1931). Unlike many other mammals, the coyote does not hibernate in winter (Cahalane 1961).

NESTING AND BEDDING REQUIREMENTS:

"No grass, leaves, or other bedding is used" (Cahalane 1961).

RITUAL REQUIREMENTS:

"About the time that the young are two months old, the mother permits her mate to return to the family den and make the acquaintance of his progeny. Hunting lessons follow. Both parents take the brood out in the fields and show them how to hunt for mice and rabbits" (Cahalane 1961). Cahalane (1961) further states that once the hunting skill has been mastered by the young, they must seek out their own hunting territory; they encounter strong resistance when they encroach upon the established territories of others.

Vocalization may be regarded as a ritual. McCarley (1975) made a two-year study of these canines in Texas and Oklahoma with particular emphasis on their long-distance vocalization. He made recordings and produced sonagrams of eight different sounds. He felt that these sounds served as a means of communication. "Their rapid falsetto barking mixed with short howls often has the effect of sounding as if several were engaged in a chorus, when there is really only one" (Bailey 1931). "Coyotes...show a vast array of vocal, facial, and postural expressions" (McMahan 1975). She (McMahan 1975) suggests that this repertoire implies that coyotes were more social animals than they appear today.

Coyotes are regarded as intelligent mammals. One significant indicator of this is their playful behavior even as adults. They frequently attempt to capture leaves, rocks, or even water (McMahan 1975).

The precopulatory behavior of two captive coyotes was observed during the late fall and early winter of two successive years (1973-1974 and 1974-1975). During the latter part of November, the female's urine became attractive to the male. He would sniff intensively around the area where she had urinated, urinate over her "mark," and vigorously scrape the ground with his paws. The urination and scraping sequence continued with increasing frequency throughout December, January, and February. During this period, the female began typical "male" leg-lift while urinating. During February, the male became more attentive to the female, frequently placing one of his forepaws or chin on her back. Mounting occurred with increased frequency throughout February and March. Successful copulation was achieved in March (Bekoff and Diamond 1976).

POPULATION STRUCTURE:

Coyotes have increased their numbers in North America despite widespread efforts to eradicate the species. "Due to their large and frequent litters, cleverness, and adaptability, they have spread and increased greatly, in spite of such wide persecution" (Cahalane 1961). There are no estimates of total numbers of coyotes, but some population density estimates are available. Knowlton (1972) estimates a density of three to five individuals per section (2.59 km^2) in south Texas compared with less than two per section (2.59 km^2) in many other areas of the United States. In a mixed farming-boreal forest ecosystem of central Alberta, Nellis and Keith (1976) estimated densities of "...between 6 and 40, 9 and 60, and 4 and 27 per 100 km^2 in winters 1965-66, 1966-67, and 1967-68, respectively." McMahan (1975) points out that although coyotes now occupy their maximum range, their density has decreased in many areas because of the newer and more sophisticated killing techniques now available.

REPRODUCTION AND SURVIVAL:

Pups are born usually in March or April after a gestation period of 60-63 days. Litter size ranges from 3 to 19, with the average being 5-6 (Bailey 1931, Cahalane 1961). Age is an important factor in influencing pregnancy rate; 94 percent of the adults and only 14 percent of the yearlings had placental scars from the most recent breeding season (Nellis and Keith 1976). Mortality of pups between birth and one year of age was estimated at 68 percent by Nellis and Keith (1976) and 67 percent by Robinson and Cummings (1951). Average annual adult mortality rates were estimated at 36-42 percent by Nellis and Keith (1976) and 56-68 percent by Robinson and Cummings (1951). Knowlton (1972) reported maximum ages of 13.5 years for a male and 14.5 years for a female.

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APPENDIX I: NARRATIVE FOR GOLDEN EAGLE

FAMILY:

Scientific Name: Accipitridae (AOU 1957, revised 1973)

Common Name: Hawks, Kites, and Eagles

SPECIES:

Scientific Name: Aquila chrysaetos (AOU 1957, revised 1973)

Common Name: Golden eagle

LEGAL STATUS:

"Although a federal law was enacted in 1962 to provide protection for the species, limited seasons have been opened in many parts of the western states for killing eagles that are purported to be taking livestock" (McGahan 1968). Public law 92-535, Fish and Wildlife-Protection of Bald Eagle (1972) protects both bald and golden eagles, eggs, and their nests from being taken or transported. Livestock-destroying golden eagles may be taken for falconry.

VALUE POTENTIAL, POSITIVE:

"This magnificent eagle has long been named the King of Birds, and it well deserves the title. It is majestic in flight, regal in appearance, dignified in manner, and crowned with a shower of golden hackles about its royal head. When falconry flourished in Europe, the golden eagle was flown only by kings. Its hunting is like that of the noble falcons, clean, spirited, and dashing. It is a far nobler bird in every way than the bald eagle and might well have been chosen as our national emblem. But then the golden eagle is not a strictly American bird, as the bald eagle is" (Bent 1937). Bent also states that "it can be seen... that the golden eagle is a very dangerous bird, a powerful influence for either good or evil according to the conditions in its habitat. Its natural and favorite food during most of the year consists of a long list of injurious rodents, which are prolific breeders. Where the eagles can keep these rodents in check, they are of great benefit to agriculture. But where they do much damage to domestic

animals, the eagles may have to be controlled. Eagles kill some fawns and a great many grouse, but let us remember that all these wild creatures have existed for untold ages in apparent balance. Probably the eagle's victims include more of the weak and sickly individuals than of the strong and healthy ones, which greatly improves the strain and produces a healthier and more vigorous race by the survival of the fittest."

VALUE POTENTIAL, NEGATIVE:

"There are many old tales of eagles carrying off young children, but most of them are pure fabrications by sensational reporters. An eagle, if pressed for food, might carry off a small baby that had been left in the open unprotected, but such an opportunity must occur very rarely. Stories of babies being found in eagles' nests, practically unharmed, are purely imaginary, as eagles are well known to kill their prey at once" (Bent 1937). Forbush (1927) describes a case of an eagle attacking a nine-year-old girl and cutting and bruising her arm quite badly before it was beaten off. Bent (1937) doubts that an eagle could lift anything heavier than a very small baby.

DESCRIPTION:

Roberts (1955) provides the following capsule description of the species: "Legs densely feathered to toes; basal joint of toes reticulate, others scutellate, margined, very rough underneath, a small web between outer and middle toes at base; bill neither toothed nor notched, but strongly hooked; wings pointed by 3rd to 5th quills, the outer 5 strongly notched on inner web, the 6th slightly so; feathers of head and neck, especially nape, taper-pointed, loose; tail of 12 feathers. Adults - dark brown or brownish black, feathers with more or less light edgings, especially on wing coverts; tawny on legs and sometimes on breast; back of head, hindneck, and sides of neck tawny or golden brown, varying in shade, sometimes almost white mixed with rufous; wings above black or brownish black, below black with a grayish area back of the coverts; tail black or brownish at end, otherwise more or less

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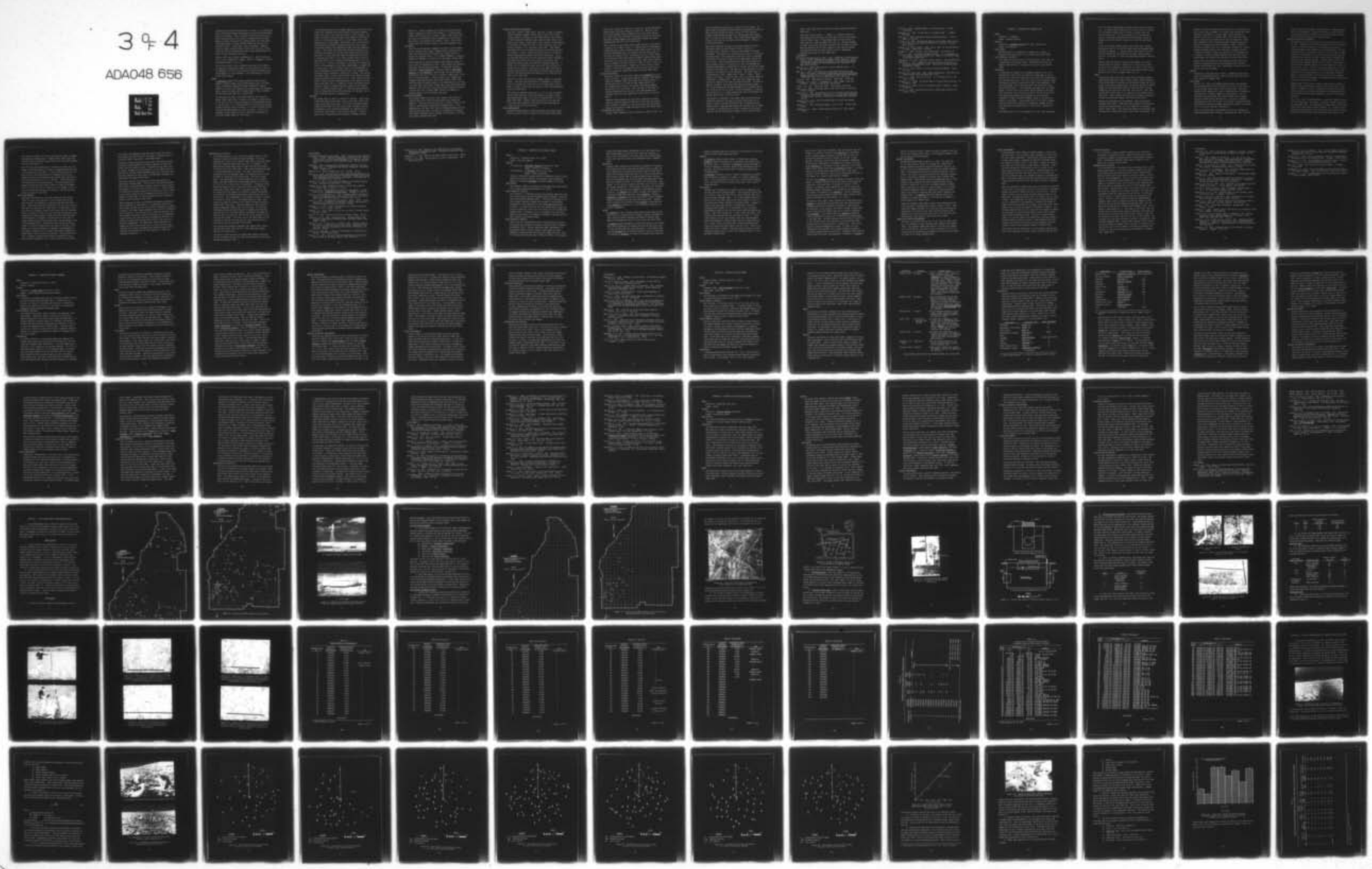

wavy-barred or mottled with lead-color or white, or, in less mature birds, the middle feathers largely white and the others extensively white on inner webs. There is always a broad dark terminal band. Bill bluish horn-color; cere yellow or greenish-yellow in adult, darker in young; feet yellow or greenish yellow; iris dark brown. With advancing age, the head becomes lighter and the tail less extensively white. Downy young - white or grayish. Immature birds are darker than the adults; a white area near bend of wing below; and the tail largely white with a black terminal band, the amount of white decreasing with age."

Roberts (1955) gives typical measurements as: length from tip of bill to end of largest tail feather, 30-40 in.; wingspan, 75-90 in.; and maximum weight, 14 lb 12 oz.

Jollie (1947) reports that a complete molt requires two seasons. In observing a one-year-old female, he noted that from 1 March to 30 September of the first year she molted about 1850 feathers and from mid-March to early September of the following year, an additional 2600 feathers.

RANGE:

A. chrysaetos ranges "from Norway, Lapland, northern Russia, Siberia, northern Alaska, and northern Canada south to Scotland, Spain, the Pyrenees, Balearic Islands, mountains of Morocco, Algeria, and Tunis, the Caucasus, Iran, Baluchistan, the Himalayas, China, Korea, and Japan, and to central Mexico, Texas, Tennessee, and North Carolina" (AOU 1957, revised 1973).

In discussing the range of the golden eagle in North America, Fisher (1893) states that "it seems to be nowhere a common species in the east, but it is much more numerous in the mountainous parts of the far west. It is confined chiefly to the mountains and more northern latitudes, where it breeds. It is able to endure intense cold and sometimes remains far north in winter. In fact, its movements at that season are more in the form of wandering for food than regular migration to the south."

In discussing migration of the golden eagle Bent (1937) writes that "eagles are sometimes found long distances from their breeding areas, while others will brave the winter in high latitudes. The species is known to winter casually north almost to the northern limits of its breeding range, and it is not known south of the southern parts of this range. Nevertheless, most of the northern breeding birds do withdraw southward during the winter season. Its movements appear to be wanderings rather than true migratory flights. Such travels are apparently influenced largely by the available food supply, and to some extent eagles will follow the migrations of other birds when these are being hunted for food, in consequence of which it is a fairly regular winter visitor in many large regions of its general breeding range where it is not known to nest. Failure of the hares or other food is probably the cause of the appearance of relatively large numbers of eagles even in recent years. The low eastern ranges of the Appalachians in eastern Pennsylvania and New Jersey are thus still frequented by the golden eagle in migration, especially in autumn. Thus during 1935 (Broun 1936) a total of 66 individuals were observed at Hawk Mountain Sanctuary near Drehersville, Pa. Golden eagles have been noted to arrive on their breeding grounds in the north as follows: Yukon--Forty Mile, April 5; Alaska--St. Michael (probably winters casually), March 10; Kigluaik Mountains, March 27; Coal Harbor, April 3; and Mount McKinley, April 8. They have been observed to leave in autumn from Alaska (Mount McKinley) on September 21, and Yukon (Plateau Mountain) on September 23."

HABITAT:

The golden eagle is found in a variety of habitats. Dixon (1911) states that eagles in San Diego County, California, prefer cliff locations in rough rocky areas. In a study in Montana, McGahan (1968) reported that of the 92 occupied and unoccupied nests he investigated, cliff locations and Douglas fir comprised 62 and 29 percent, respectively, of the favored locations. He also states that "81 percent were at altitudes of between 4000 and

6000 feet." Similar findings were reported by Wellein and Ray (1964) in Wyoming, Colorado, and New Mexico. In Alaska, Murie (1944) found 23 nests, all on cliffs. Gordon (1955) states that all nests in the Scottish central highlands are in Scotch fir, while those in the Hebrides are always on cliffs. Dixon (1937) reports that tree nests are always in oak and eucalyptus trees.

FOOD HABITS:

"The food consists mainly of mammals and birds, of which spermophiles, rabbits, fawns, lambs, turkeys, grouse, waterfowl, and other large birds form the principal part, though offal and carrion are sometimes taken... Of 6 stomachs examined, 1 contained feathers; 2, mammals; 2, carrion; and 1 was empty" (Fisher 1893).

During 1962-1964 in Montana, McGahan (1968) examined remains of prey as well as regurgitated pellets of both adults and young and identified 980 individual specimens. He found that whitetail jackrabbits (Lepus townsendii), cottontail rabbits (Sylvilagus audubonni and S. nuttallii), various birds, and various snakes represented 37.2, 32.6, 12.4 and 0.4 percent, respectively, of the diet of the golden eagle. Various authors (e.g. Craighead and Craighead 1956, Kennedy 1948, Lehti 1947, Willard 1916b), have reported attacks by golden eagles on live game species, and others (e.g. Bent 1937, Gordon 1955, Lockie 1964, Lockie and Stephan 1959, Musselman 1942, Smith 1915, Wood 1946) discuss attacks on domestic livestock and fowl. McGahan (1968) reports no predation in domestic species in his principal study area.

SHELTER REQUIREMENTS:

Since golden eagles occur over a wide range, a wide variety of shelter types can be found (see discussions under RANGE and HABITAT). "The choice of nest sites is, of course, limited by the range of environmental possibilities" (McGahan 1968). Also, McGahan points out that cliff sites are extremely popular choices when available and that in two years of observation of occupied cliff nests in Montana that an average of 49 percent of the time, the southern exposure was chosen.

NESTING AND BEDDING REQUIREMENTS:

"The nest is made of large sticks, some over 2 inches in diameter, firmly interwoven, smaller sticks, twigs, brush, roots, grass, leaves, pieces of sacking, and other bulky rubbish; the lining is of softer materials, grasses, weeds, dead and green leaves, soft mosses, and lichens. Green grass, or green leaves, often attached to the twigs, are added from time to time, especially after the young are hatched. M. S. Ray says in his notes: 'The lining frequently varies with the particular pair of birds and also with the locality. A nest I found at a high altitude on a lofty and barren mountainside was merely lined with coarse roots. One in an oak-wooded canyon was lined with eucalyptus leaves, although no such trees were visible for miles around. Another nest was beautifully draped, hung, and lined with gray-green oak moss. So thickly was it covered with moss that it was very difficult to discern from a distance. Nests found in the humid coast belt in the great redwood forests were much more warmly lined; a typical nest was very thickly lined with rabbit fur, also some moss and eagle down'" (Bent 1937).

Dixon (1911) found nests lined with dagger, pepper, or eucalyptus leaves. "The odor from these leaves is distasteful to bugs and lice of all kinds, and I think this is the reason they took such pains to secure it when there was plenty of other nesting material close by" (Dixon 1911).

"New nests are sometimes quite small, 2-1/2 to 3 feet in diameter and 18 inches high, but as they are added to from year to year, they become quite bulky, 5 or 6 feet in diameter and 4 or 5 feet high" (Bent 1937). Bendire (1892) describes one nest that was 7 feet high and 6 feet wide, and Willard (1916a) describes one "6 feet one way by 8 feet the other."

RITUAL REQUIREMENTS:

Territorial requirements of the golden eagle are extremely large, 93 km^2 or about 37 times as large as the bald eagle (Welty 1962).

Dixon (1911) states that each pair of birds has its own nesting and hunting range from which others are driven out. They will, however, steal material from a neighbor's nest, which often results in a fight "over their stealing, diving and circling in the air and sometimes clashing together and falling thus several feet before breaking away from each other" (Dixon 1911).

"The courtship of the golden eagle is much like that of the Buteos, to which it is closely related. It consists mainly of spectacular flight maneuvers, spiral sailings in ever-rising circles, in which the birds frequently come close together and then drift apart; as they pass they almost touch. Occasionally one will start a series of nose dives on half-closed wings, swooping up again between dives and giving vent to his joy in musical cries. This form of nuptial play is indulged in by both sexes and is kept up, more or less, all through the nesting season. Perhaps it is only a form of joyful exercise. The birds are apparently mated for life, and if one is killed, the survivor immediately seeks a new mate" (Bent 1937).

POPULATION STRUCTURE:

Population figures for the entire range of _A. chrysaetos_ are difficult to obtain. In discussing population density in his Montana study area, McGahan (1968) states that "the average density of nesting pairs (17-19) in 1963 and 1964 ranged from 66.3 to 74.2 square miles per pair; the distance separating neighbors varied from 1.0 to 10.5 miles. More than half of the pairs observed attended more than one nest, such supernumerary nests averaged 1.8 per pair and ranged from several feet to 3.8 miles apart."

Henderson (1920) reported that the winter population of golden eagles in northern Alberta in 1907 was so great that the species was a nuisance to trappers but that these birds were practically absent in the winter of 1908, when prey species had become scarce.

REPRODUCTION AND SURVIVAL:

McGahan (1968) examined 13 nests in 1964 and 7 nests in 1965. He

found an average clutch size of 2.1 eggs for the two years. He states that 45 successful nesting efforts were observed in 1963 and 1964, and these yielded 81 young, of which 70 (86.4 percent) fledged; these figures indicate that 1.59 young per nest hatched and 1.37 young per nest fledged. Bent (1937) reports egg dates as 27 May to 29 June in Arctic America and 9 February to 18 May in California and Texas.

Bent (1937) describes the eggs of the golden eagle as follows: "The shape varies from short-ovate to oval, or rarely to elliptical-oval; the shell is thick and from finely to coarsely granulated. The ground color varies from dull white to 'cream-buff' or pinkish white. The variations in types and colors of markings are endless, but series of eggs from the same female usually run true to type. They are generally more or less evenly marked with small blotches, spots, or fine dots, but often the markings are unevenly distributed or concentrated at one end, and some are evenly sprinkled with minute dots. The eggs are often sparingly or faintly marked, or even nearly or quite immaculate. The usual colors of the markings are 'bay,' 'amber-brown,' 'hazel,' 'tawny,' 'Mikado brown,' 'clay color,' 'vinaceous fawn color,' and various shades of 'ecru-drab' or 'Quaker drab.' Some very pretty eggs have large blotches or washes of the drabs overlaid with browns. The measurements of 59 eggs in the United States National Museum average 74.5 by 58 millimeters; the eggs showing the four extremes measure 85.7 by 64.3, 67.5 by 53, and 70.7 by 49.4 millimeters. An egg in the collection of C. S. Sharp measures 89 by 66.6 millimeters, the largest egg of which I have any record."

"The period of incubation of the golden eagle has been variously reported as from 28 to 35 days; the latter figure seems to be based on the most accurate observation and is probably the most nearly correct. Most observers agree that the male does not assist the female in incubation, but he feeds his mate on the nest and helps to care for the young by bringing in food, which his mate

feeds to the young, and by brooding the young occasionally himself" (Bent 1937).

Bent (1937) reports that E. L. Sumner, Jr., observed a brood of young eaglets in California, and these birds left the nest between 9 and 10 weeks of age. "Young eagles remain in the vicinity of their nest for a long time after they leave it. They are probably at least three months old before they gain the full power of flight. They are partially fed by their parents at first and are watched and guarded by them until they learn to hunt for themselves, probably until early in fall" (Bent 1937).

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APPENDIX J: NARRATIVE FOR MOURNING DOVE

FAMILY:

Scientific: Columbidae

Common: Pigeons and doves

SPECIES:

Scientific: *Zenaidura macroura* (AOU 1957, revised 1973)

Common: Mourning dove

LEGAL STATUS:

The mourning dove is protected as a songbird in a number of northern states and hunted in the southern states (Bent 1932).

VALUE POTENTIAL, POSITIVE:

This species is valued as both a "table delicacy" (Bent 1932) and a popular game bird (Bryant 1926). Mourning doves provide the largest annual harvest of any game bird in this country (Peters 1961).

DESCRIPTION:

In observing the changes in the plumages during the life of the mourning dove, Bent (1932) notes that the young squab is fat and unattractive, scantily covered with short, white down through which the yellowish skin shows. The stiff quills of the juvenile plumages soon appear, giving the young bird an ugly, spiny appearance. The juvenile plumage is well developed before the young birds leave the well-filled nest. In this plumage, the upper parts are "buffy brown" to "snuff brown," with faint, whitish edgings on the back and wing coverts; the scapulars and some of the inner wing coverts have large black patches; the underparts are from "pinkish cinnamon" to "light vinaceous-cinnamon," paler on the belly and grayer on the flanks. A postjuvenile molt of the contour plumage and tail, during fall, produces a first-winter plumage, which is like the adult but somewhat duller. Adults have a complete molt in fall.

The mourning dove in the field appears as a long, slim, gray-brown

bird with small, nodding head, whistling wings, and long, pointed tail. The sparrow hawk resembles the dove very closely in flight, but the hawk has strong, heavy shoulders, a larger head, and squarely tipped tail. The little ground dove of the southern states is instantly distinguished from the mourning dove by its stumpy tail and the flash of bright color under the wing (Bent 1932).

"Since the Passenger Pigeon became extinct about 1900, constant mistakes are made in the field by identifying high-plumaged Mourning Doves as Pigeons. ...The black spot on the side of the head below and behind the ear, present in the adult Mourning Dove, absent in the Pigeon, is a safe distinguishing character" (Roberts 1955).

Roberts (1955) describes the physical size ranges of the adult mourning doves as follows: length (tip of bill to end of tail), 11.00-13.00 in.; wingspan, 17.00-19.00 in.; tarsus, 0.75-0.85 in.; and bill, 0.46-0.60 in. He also gives the average weight of male adults as 4.75 oz and of females adults as 3 oz.

RANGE:

The mourning doves range from Alaska, British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Maine, and new Brunswick south through Mexico (including the Tres Marias Islands and Clarion Island in the Revilla Gigedo group) and Central America to western Panama, and from the Bahama Islands to Cuba, the Isle of Pines, Hispaniola, and Puerto Rico (AOU 1957, revised 1973). AOU (1957, revised 1973) states that it is a migrant in the northern part of this range. Fossil remains have been found in Kansas, California, Florida, and Nuevo Leon, Mexico (AOU 1957, revised 1973).

Between late September and late November, these birds migrate southward (Bent 1932). "They spend their winters in the southern states and Central America, but a few remain in the northern states" (Dorst 1956). The returns from banded birds indicate that the majority of these birds move in winter well to the south. For

example, one banded at Wauwatosa, Wisconsin, on 6 June 1929 and was shot in Dale County, Alabama, on 3 January 1930; another was banded at Madison, Wisconsin, on 12 April 1929 and was recovered at Jennings, Louisiana, on 2 December 1929. The region from Texas east to Georgia is the favored winter home of the species. Eight birds banded at points in Nebraska, Kansas, Minnesota, Missouri, Illinois, Indiana, and Ohio were retaken in Texas; 7 banded in Illinois and Indiana were shot in Louisiana; 10 banded in Illinois, Indiana, Michigan, and Ohio were recovered in northern Florida; 4 banded in Illinois, Indiana, and Ohio were shot in Alabama; and 14 banded in Illinois, Indiana, Michigan, New York, New Jersey, Pennsylvania, and Virginia were recovered in Georgia (Bent 1932).

Lowery (1974) also points out that banding returns indicate the majority of mourning doves in Louisiana mainly come from Ohio, Indiana, and Michigan with "only a sprinkling of doves from as far west as even Iowa or Kansas."

HABITAT:

"During the nesting they may be found... generally in open woodlands or tree-bordered fields. They also visit roads and lanes to dust themselves" (Chapman 1897).

FOOD HABITS:

Martin et al. (1951) list pigweed, wheat, croton, and sunflower as each comprising at least 5 percent of the diet of this species in the mountain desert region of the United States. Davis and Anderson (1973) examined 274 craws of mourning doves in New Mexico and performed a volumetric analysis of the contents. For the specimens collected during 1971, they determined that sorghum, pecan, and Johnson grass comprised 42.1, 11.8, and 9.5 percent, respectively, of the total volume of food eaten. During 1967-1968, the preferred foods were sorghum, desert horse purslane, and barley, 51.2, 12.9, and 6.8 percent, respectively.

After the nesting season, doves gather in flocks of varying size and frequent grain and cornfields. During the day, they visit the

nearest supply of fine gravel, which they eat in large quantities as an aid to digestion. In some localities, soon after sunset, they regularly repair in numbers to some favorite place to drink and then retire to their roosts (Chapman 1897).

NESTING AND BEDDING REQUIREMENTS:

The mourning dove uses a very wide choice in selecting a site for its nest. Perhaps the site most nearly typical is not far from the trunk on a horizontal branch of an evergreen tree--a pine or cedar--affording a firm foundation for the flimsy nest. The bird frequently nests on the ground, however, even on a clump of grass, sometimes on the stump of a tree, and there are several recorded instances where the nest has been found placed on a wooden ledge attached to an inhabited building. Indeed, Gardner (1927) says that the birds in Kansas "preferred the vicinity of buildings to the wooded and secluded canyons of the back country by a ratio of at least ten to one." The chief requisite, apparently, is a level support that will give stability to the nest; and to acquire the security, the dove often makes use of the experience of another species of bird and builds its own nest on a nest (for example, that of a robin, brown thrasher, or mockingbird) that has weathered the previous winter (Bent 1932).

Simmons (1925) reports that in Texas the nest of this species is placed "rarely on leaning corn-stalks, rail fences, tops of rock fences, or ledges in cliffs. Occasionally old nests of the gray-tailed cardinal or the western mockingbird are repaired and used; one bird with eggs was found occupying an old nest of the Audubon caracara."

"As a rule, a pair of mourning doves... nests well removed from the nests of other doves" (Bent 1932). There are, however, exceptions to this general rule. In Mississippi, Stockard (1905) reports that these doves often nested in small colonies: "In a clump of about fifteen young pine trees, I once found nine nests, and in an Osage Orange about one-half mile long twelve nests were located. But

most doves nest singly, or with the nests too far apart to suggest any gregarious nesting habit." Chapman (1897) states that nests of these birds are usually "within ten feet of the ground" although "rarely on the ground..."

Most often the nest, perhaps just a platform of sticks, but firm enough to withstand usage for 30 days, is apparently made entirely by the female bird (Bent 1932). In the building of the nest, the male bird will provide assistance by obtaining sticks for the female who serves as the architect and builder (Bent 1932 reporting the unpublished notes of F. F. Gardner). "Nest building as a rule takes place in the early morning. The male mourning dove gathers the materials and carries them to his mate who arranges them. He takes one piece at a time, and if he happens to drop it, he does not stop but continues his journey to the tree and then starts over again" (Nice 1922).

RITUAL REQUIREMENTS:

Other than observations of courtship rituals by a few authors, "very little has been published in the courting action of the mourning dove, and apparently no detailed study has been made of them. Indeed many observers who know the bird will state that they have seen no courting at all" (Bent 1932). In observing a courtship flight in Michigan, Barrows (1912) writes that "an individual leaves its perch on a tree, and, with vigorous and sometimes noisy flapping (the wings seeming to strike each other above the back), rises obliquely to a height of a hundred feet or more, then on widely extended and motionless wings, glides back earthward in one or more sweeping curves. Usually the wings, during the gliding flight, are carried somewhat below the plane of the body, in the manner of a soaring yellowlegs or sandpiper, and sometimes the bird makes a complete circle or spiral before again flapping its wings, which it does just before alighting. This peculiar evolution is commonly repeated several times at intervals of two or three minutes and appears to be a display flight for the benefit

of its mate, the assumption being that only the male dove soars." Other authors who have written of courtings in mourning doves include Goss (1891), Craig (1911), and Forbush (1927).

"Although mourning doves spend a large part of the year in flocks, they have a strong tendency in spring to separate into pairs and scatter over the country to nest. Doubtless they owe their present status, perhaps even their existence, to this habit, for, had they bred in colonies as the passenger pigeon did, the doves would have been subjected at their nests to the wholesale slaughter that exterminated the pigeon" (Bent 1932).

"The sweet, sad call of the male has won for this species its common name" (Chapman 1897). "This is one of the bird notes that, while fairly loud and perfectly distinct, does not readily attract the attention of one who is not familiar with it. In this respect, it resembles the diurnal hooting of the screech owl; both of these notes in some strange way are disregarded by the ear until it is trained to detect them. We then recognize them both as familiar sounds of the countryside" (Bent 1932).

"When delivering his song, the mourning dove does not perform any dance or gesture, as some birds do. He invariably stands still when cooing; even when he coos in the midst of pursuing the female, he stops in the chase, stands immovable until the coo is completed, and then runs on. His attitude is to be sure very definite, the neck somewhat arched and the whole body right, but the impression it gives one is, not that the bird is striking an attitude, but that he is simply holding every muscle tense in the effort of a difficult performance. The female also utters the perch-coo, though less often than the male, and in a thin, weak voice and staccato tones, which, as compared with the male's song, form so ludicrous a caricature that on first hearing it I burst out laughing" (Craig 1911).

REPRODUCTION AND SURVIVAL:

"The breeding season is very long; in the middle states it lasts from May to August and rarely to early September. The birds commonly rear two broods in a season" (Bent 1932) or possibly three (Bent 1932 reporting unpublished notes of A. R. Sherman). "The mourning dove almost always lays two eggs, but there are records of three or even four" (Bent 1932). Bent (1932) describes the eggs of the mourning doves as follows: "In shape, they vary from elliptical oval, the commonest shape, to elliptical ovate or ovate. The shell is smooth with very little gloss. The color is pure white. The measurements of 47 eggs average 28.4 by 21.5 millimetres; the eggs showing the four extremes measure 31 by 22, 29.5 by 23, 26 by 20.5, and 28.5 by 20 millimetres." During the 15-day incubation period and the 15 days which follow, both "male and female take regular daily turns in sitting on the eggs or young, the female sits from evening till morning, the male from morning till evening, the exchanges taking place usually about 8:30 a.m. and 4:30 p.m. This arrangement is very regular if there is nothing to disturb the birds; but if interloping birds come about, this arouses the anger of the male, and he leaves the nest in order to attack them" (Craig 1911). When the young are in the nest "both parents regurgitate 'pigeon milk' for the young. Two striking differences between the nest behavior of mourning doves and most passerine birds is the almost constant brooding of the young till near the end of the nest life and the lack of any sanitary care of the nest (Nice 1923). "As a rule, one or the other parent is continuously on the nest from the time the first egg is laid until the young are fairly well grown" (Nice 1923).

Insects and seeds gradually supplement the "pigeon milk," and at the time these birds leave the nest, these items have largely replaced the "pigeon milk."

One report of 5448 recoveries of banded birds showed a mortality rate of 70 percent for the first year and 55 percent for each year thereafter (Anonymous 1957).

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APPENDIX K: NARRATIVE FOR COTTONTAIL RABBIT

FAMILY:

Scientific: Leporidae (Jones et al. 1975)

Common: Hares and rabbits

SPECIES:

(1) Scientific: Sylvilagus nuttallii (Jones et al. 1975)

Common: Nuttall's cottontail

(2) Scientific: S. audubonii (Jones et al. 1975)

Common: Desert cottontail

While this narrative includes specific information on both of these species of cottontail rabbits, the majority of the information applies to the genus Sylvilagus (cottontail rabbit) as a group.

LEGAL STATUS:

The cottontail rabbit is protected by state game laws in all states of its range except Nevada (Barnes et al. 1970).

VALUE POTENTIAL, POSITIVE:

The cottontail "...furnishes sport for more hunters than all of the deer, moose, bears, and other big-game species combined." Millions are killed annually (Cahalane 1961). "Cottontails form much of the diet of many carnivorous animals and, because of their general availability, reduce predation on less common game species and livestock. By converting plant food into animal matter, they constitute an important link in the "food chain of life" (Schwartz and Schwartz 1959). "Cottontail fur is not durable so it has little commercial use except for trimming on children's coats and hatter's felt" (Schwartz and Schwartz 1959).

VALUE POTENTIAL, NEGATIVE:

"They serve as an intermediate host for many parasites of carnivorous species and transmit the disease, tularemia to man" (Schwartz and Schwartz 1959). "Rabbits sometimes commit depredations in truck gardens where they eat lettuce, beans, peas, and other vegetables, especially when the plants are young and tender. Most of the plants nibbled grow near the edge of fields, for cottontails

seldom feed farther than a hundred feet or so from brushy cover. More lasting damage is done in winter, when dire necessity, at times, forces the animals to eat berry canes and to girdle apple, cherry, and other fruit trees, and ornamental shrubs" (Cahalane 1961).

DESCRIPTION:

Cahalane (1961) describes the cottontail in general as "a medium-sized rabbit with fairly long ears and medium long hind legs, fur soft, reddish brown to grayish brown above, white on under parts except the brownish throat; the short tail is brown above and pure white beneath, except some of the marsh rabbits whose tails are gray on the underside, and the brush rabbit and pigmy rabbit whose tails are brownish or buffy. Size varies with the species: total length, 11 to 22 inches; height at shoulders, 6-1/2 to 7-1/2 inches; and weight, generally 2 to 3-1/2 pounds, or rarely up to 6 pounds." The two species may vary only slightly in their physical characteristics. S. audubonii has a greater average total length, and its average weight may exceed that of S. nuttallii. "From S. audubonii, S. nuttallii differs in shorter ears, smaller tymphanic bullae, and smaller hind legs (Hall and Kelson 1959). Cahalane (1961) describes the coloration of S. nuttallii as gray and that of S. audubonii as brown but "...not as brightly colored as the eastern cottontails."

RANGE:

S. nuttallii occurs in western United States from Arizona and New Mexico north to southern British Columbia, Alberta, and Saskatchewan, and from central California and Oregon to eastern North Dakota and Nebraska and central Colorado (Hall and Kelson 1959).

S. audubonii ranges throughout the plains and deserts of the southwest from central Mexico to Montana and from the California coast to Texas and Oklahoma (Hall and Kelson 1959). In the Pike's Peak area, S. nuttallii has an elevation range of 6,000 to 11,500 feet. In Colorado, S. audubonii is found at elevations below 7,000 feet;

however, specimens have been collected at an elevation of 7,700 feet in the San Luis Valley (Armstrong 1972).

HABITAT:

S. nuttallii normally prefers wooded or brushy areas, while S. audubonii lives on the plains or in relatively open country (Hall and Kelson 1959). In Colorado, S. nuttallii occupies the edges of forests at moderate elevations, except in the northwestern part of the state and San Luis Valley, where it inhabits treeless areas (Armstrong 1972).

S. audubonii in western Colorado occupies "brushlands and woodland edge situations in canyons, in valleys, or on mesas" (Armstrong 1972). In the eastern part of the state, it uses similar habitats, but it can also be found in treeless areas where cover is sparse (Armstrong 1972).

FOOD HABITS:

"Probably the cottontail eats a greater variety of vegetable food then any other North American mammal. Every naturalist agrees that it is easier to name the foods that it leaves untasted than those that are eaten" (Cahalane 1961). Its two main feeding periods are three to four hours after sunrise and late afternoon to three to four hours after sunset (Schwartz and Schwartz 1959). A number of studies (e.g. Dalke and Sime 1941, Sweetman 1944, Todd 1927, Trippensee 1938) comment on the food habits of the cottontail. These authors point out that the diet varies with availability and season. Todd (1927) states that "...where their food grows, there is their home, provided they can find places to hide..." Hickie (1940) points out that sound cultural land and stock management practices favorable to wildlife benefit both the farmer and wildlife. Hickie (1940) also stated that evergreen plantings check erosion and soon become good habitat food and cover. Martin et al. (1951) note that "in summer cottontails subsist largely on tender herbaceous plants, while in winter they frequently resort to twigs and bark of young trees."

Martin et al. (1951) list elderberry, oak, and apple as each comprising 2-5 percent of the diet of S. nuttallii, and sassafras, willow, hickory, grape, buckthorn, and wild rose as items that collectively provide less than 2 percent of the diet of this species. They state in Utah that black chokecherry, snakeweed, bitter brush, Oregon grape, and sagebrush are used as food items by S. nuttallii, but the extent of their importance is not known. Bailey (1931) simply states that S. nuttallii consumes "...as great variety of plants and green vegetation as that of any other species," but he points out that little is known about the diet of this rabbit (i.e. specific plant species consumed).

The diet of S. audubonii consists in general of grasses, birch, and aspen. In Arizona, mesquite and prickly pear are very important, comprising collectively about 50 percent of the diet of this species. In numerous field observations at the San Joaquin Experimental Range, California, in all seasons the following plants were found to be consumed by S. audubonii: filaree, bromegrass, fescue grass, popcorn flower, clover, deer vetch, tarweed, turkey mullein, spikerush, and rush (Martin et al. 1951).

From 1936 to 1940, Ingles (1941) observed the eating habits of S. audubonii in California and determined that they preferred green herbaceous plants (both wild and cultivated) to woody material. He found that, on the average, the species consumed a larger quantity of solid food (by weight) than did its eastern counterpart (S. floridanus). In a later study of S. audubonii, Turkowski (1975) classified the contents of 97 stomachs by the percentages of the total bulk. He found that grasses constituted 27.9 percent of the "relative bulk" (by occurrence), while forbs and shrubs accounted for 41.3 and 20.8 percent, respectively. Even a trace amount of arthropod fragments was found. He points out that "cottontails also adjusted their feeding patterns according to prevailing habitat moisture conditions." Turkowski (1975) observed that during dry periods (July-September) consumption of Opuntia, a

cactus (80 percent moisture content by weight) increased to 80 percent of the "relative bulk," while it was completely ignored during the wet period (October-November).

SHELTER REQUIREMENTS:

The expectant mother digs a hole 6-7 in. long, 5 in. wide, and 3-4 in. deep to form a burrow in the shape of a shallow bowl. Whenever possible she uses an existing depression, such as a cow or horse track or an abandoned home of some other animal (Cahalane 1961). This depression or burrow is sometimes referred to as a "form." The forms in an area are used by all cottontail residents, but "...there may be ownership of specific ones" (Schwartz and Schwartz 1959). They further state that underground dens of other animals (e.g. woodchucks) are used as temporary homes during periods of heavy snow. The form is concealed whenever possible under a dense pile of brush or a clump of grass, or in a thicket. Cottontails generally remain in these forms during the day and venture out during late evening and early morning (Schwartz and Schwartz 1959). S. audubonii may seek temporary safety from predators in prairie dog towns or in the burrows of badgers or large kangaroo rats (Bailey 1931).

Beule and Studholme (1942) made a study of the nesting activities of the cottontail including the locations chosen for nests. They found that "unkept orchards" (1.54 acres per nest) and young pine plantations (2.0 acres per nest) were favored locations, while pastures (14.0 acres per nest), woods (13.5 acres per nest), and fallow fields (13.0 acres per nest) were least favored.

NESTING AND BEDDING REQUIREMENTS:

The form is lined with grass or bits of fur that the female pulls out of its abdomen or chest (Cahalane 1961, Schwartz and Schwartz 1959). The expectant female may prepare a nest and later abandon it to build another, and rarely a third, especially if it is disturbed (even by plundering mice searching for nest material) before the birth of her young (Cahalane 1961).

RITUAL REQUIREMENTS:

"Courting rabbits often engage in hopping contests. A pair will face each other. Then one rabbit leaps straight up in the air and the other dashes underneath. Turning about, they may repeat the routine several times. Sometimes an especially desirable female may acquire a retinue of four or five males. Whether she accepts more than one of them during a single period is unknown. A day or two after pairing off, she acquires an active dislike for her current mate and turns on him violently. Biting mouthfuls of fur from his flanks and back, she chases him out of her territory... The rutting period lasts until perhaps the middle of September when most of the animals abandon their mating interests and concentrate on getting into condition to meet the rigors of winter" (Cahalane 1961).

"With the exception of females with young, cottontails are tolerant of each other. The feeding territories of males and of nonbreeding females are shared in common with very little friction. A mother rabbit, however, will not allow any other grown-up female on her home range. Trespassing beyond a border or neutral zone will cause a fight. This competition for territory by breeding females may act as a limitation on the population. Certainly the number of ranges, which are furnished with suitable cover, and dens or other shelters have a decided influence on the number of rabbits. The fortunate animals that win and can hold the best ranges are comparatively immune to attack by most enemies, while those on poorer areas suffer the greatest losses. The need for proper shelter seems to be the only reason that rabbits move from open uplands to brushy lowlands to spend the winter. These movements are short (usually less than a mile) and are the only migrations ever performed by these usually sedentary animals" (Cahalane 1961).

Dalke (1942) made an observation of a mother rabbit playing with one of her young and of two adult rabbits playing "hide and seek."

POPULATION STRUCTURE:

It is difficult to obtain population figures on the cottontail; variations in abundance do occur. These variations may be caused by diseases, changes in hunting pressures, and predators (Cahalane 1961). Furthermore, Cahalane (1961) reports a density of one rabbit per 2-3 acres in the midwest.

REPRODUCTION AND SURVIVAL:

In the northern half of the United States, cottontails have a seven-month breeding season. This season extends throughout the year in the southern states and along the Pacific Coast (Cahalane 1961). Hamilton (1940) reports male rabbits in New York capable of breeding from December-September. Nine to ten months are required for a female to reach maturity (Hickie 1940), but "...both sexes may be capable of breeding as early as six months of age" (Cahalane 1961). With 24-30 days of breeding, her litter is born (Cahalane 1961, Hickie 1940). Average litter size is five, and four to five litters per season are common even in northern latitudes. The female may breed again before her young are even one day old. Occasionally "sterile coitus" (or orgasm caused by does mounting each other) occurs. This will cause ovulation followed by pseudopregnancy (Schwartz 1942), which culminates the 17th day (Templeton 1940), or about the 16th to 19th day (Hammond and Marshall 1925) with the secretion of milk and often nest building (Schwartz 1942). Birth weight is approximately 1 oz. The young are born blind, deaf, and without hair, but they mature rapidly. When they are 12 days old, they are able to venture from their nests in search of food, and by the age of 14-16 days they leave the care of their mother. The cottontail has less than one chance in twenty of reaching its first birthday (Cahalane 1961). Haugen (1942) reported that 25 percent of the cottontails he sampled lived to an age of 21 months or more. The survival rate of these rabbits is affected by predators and hunters, as well as by ectoparasites and endoparasites (Cahalane 1961, Haugen 1942).

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APPENDIX L: NARRATIVE FOR ABERT'S SQUIRREL

FAMILY:

Scientific: Sciuridae (Jones et al. 1973)

Common: Squirrel

SPECIES:

Scientific: Sciurus aberti (Jones et al. 1973)

Common: Abert's Squirrel (Tassel-eared squirrel)

LEGAL STATUS:

In Colorado, the Tassel-eared squirrel is protected against hunting during all seasons (Nash and Ramey 1970). In New Mexico and Arizona, the species is protected under game laws. Arizona also protects the squirrel in Group IV of the state's threatened and endangered species legislation (Cahalane 1961).

VALUE POTENTIAL, POSITIVE:

In New Mexico and Arizona, Abert's squirrels are important, small game animals. Physically, however, they are one of the most beautiful squirrels in the United States (Nash and Ramey 1970). In national parks and Colorado where it is protected, the squirrel becomes tame and confident, captivating the attention of tourists in cabin and campground areas (Cahalane 1961). Recently, Abert's squirrel has received some attention from the scientific community because it is thought to represent an example of divergent evolution (Jones 1976).

DESCRIPTION:

The Abert's squirrel is a heavy-bodied large tree squirrel with notably long, broad ears; an unusually broad bushy tail; and very large feet (Cahalane 1961, McKee 1941,). The total length varies from 19 to 21 in.; height at the shoulders measures 4 to 4-1/2 in.; and weight ranges from 1-1/2 to 2 lb (Cahalane 1961). The underparts and upper surfaces of the fore and hind feet are usually white, separated from the grayish upper parts by a distinctly black lateral line. The short, broad skull with flattened frontal area, the depressed and laterally inflated braincase, the depressed,

long nasals, and the laterally compressed rostrum are principal anatomical features of the species. Unique external characteristics are its conspicuously tufted ears and coat-color polymorphisms maximum length during winter months. Three primary coat-color phases are common in Colorado: black, brown, and the more typical gray (Nash and Ramey 1970).

RANGE:

The Abert's squirrel inhabits the ponderosa pine zones of the southwestern United States, including the Colorado Plateau and the southern Rocky Mountains of Colorado, Arizona, New Mexico, and Utah. It ranges as far south as the Sierra Madre Occidental of Chibuahua and Durango, Mexico (Cahalane 1961, Keith 1965).

HABITAT:

These squirrels are restricted to a specific environment, never ranging far from the western yellow (ponderosa) pines of Transition Zone. They seem to prefer the larger stands of ponderosa scattered throughout elevations of 5,000 to 10,000 ft above sea level (Keith 1965, McKee 1941, Nash and Ramey 1970). Found in dry, cool forests of the interior characterized by moderate rainfall, Abert's squirrels have become so dependent on the ponderosa pine that the trees are used almost exclusively for both food and cover (Keith 1965).

FOOD HABITS:

Since Abert's squirrels are confined to the ponderosa pine zones, it is not surprising that they use the trees as a major food source (Keith 1965). Keith (1965) reported that Arizona Abert's squirrels feed primarily on the seeds, inner bark, terminal buds, and flowers of the ponderosa pine; fleshy fungi; carrion, bones, and antlers. The most important items in the diet appear to be pine components and fleshy fungi. Ponderosa pine seeds are apparently the favorite food of squirrles in that the seeds are taken in preference to any other food when available. Squirrels feed primarily on pine seeds from late May to November. The inner bark layer of the ponderosa pine is eaten during all seasons, with maximum utilization in

winter months, November through April. Most of the inner bark consumed is obtained from small twigs on the tree extremities. Keith (1965) observed that one squirrel usually clipped an average of 50 stems daily during the winter with clippings under a single tree rarely exceeding 100. According to Patton (1974), Larson and Schubert (1970) reported twig cuttings for a 10-year period on trees over 12-in. dbh to be 13 twigs per tree and 133 twigs per acre. Apical buds of the ponderosa pine are used most extensively from November through May. Squirrels feed alternately on inner bark and buds in the same tree with the inner bark being eaten more frequently and in greater quantities than the apical buds (Keith 1965). In early May, staminate flowers of the pine are consumed heavily. Maturing flowers are eaten until early June, when the pollen disseminates (Keith 1965). In late July, squirrels feed extensively on forest floor fungi, many of which are parasitized by larval insect forms; these parasitized fungi seem to be especially palatable and preferred (Keith 1965). Primary fungi consumed are those of the following genera: Agaricus, Amanita, Boletus, Hypholoma, Lepiotas, Lycoperdon, Russula, and Tuber. Keith found miscellaneous foods to include: carrion from dead jackrabbits (*Lepus californicus*) and procupines (*Erethizon dosatum*); deer antlers (*Odocoileus hemionus*); bones of jackrabbits, porcupines, deer, and cattle; Gambel oak mast, and seed and foliage components of unidentified herbaceous plants. According to Patton and Green (1970), research indicates trees between 11- and 30-in. dbh are preferred feed trees (Patton 1974). Squirrels may also prefer trees whose inner bark has a better taste or perhaps a higher nutritive value (Keith 1965). Keith (1965) found that branches infected with mistletoe (*Arceuthobium vaginatum*) are taken extensively in all seasons, but especially in the winter. The infected zones of these branches exhibited succulent swellings of the secondary and meristematic inner bark, which seemed highly preferred by the squirrels (Keith 1965).

SHELTER REQUIREMENTS:

The species depends on ponderosa pines for shelter as well as for food. The protective cover surrounding the tree is probably more important than the nest tree itself (Patton 1974). Trees surrounding the nesting site of Abert's squirrel in Kaibab National Forest were located in dense groups of three to five with interlocking tree crowns providing protection from weather and alternate escape routes from the nest (Jones 1976, Patton 1974, Rasmussen 1972). Patton (1974) observed that greatest densities of squirrel nests were located in interior pine stands with high crown densities of over 70 percent and averaging dbh value of 11 to 13 in.; lowest densities of squirrel nests occurred in open pine stands with crown densities of 35 percent or less and averaging dbh above 18 in. Patton (1974) suggests that tree density and tree diameter are the most important components of Abert's squirrel nest cover, the two in combination providing necessary conditions for nest protection and escape. With the exception of nursing females, the squirrels rarely use their nests for shelter during daylight hours (Keith 1965). In central Arizona, Keith (1965) examined more than 200 nests, several at frequent intervals. Squirrels were found in nests only on the first day of clear weather after snowstorms and on days during long periods of inclement weather (Cahalane 1961, Keith 1965).

NESTING AND BEDDING REQUIREMENTS:

Ponderosa pine branches provide the major nesting sites for Abert's squirrels (Cahalane 1961, Keith 1965). Nests are also found in cavities in Gambel oak (*Quercus gambeli*) and cottonwood (*Populus fremonti*) branches when these trees are available for nesting sites (Keith 1965). In central Arizona, nest trees range from 12- to 41-in. dbh; Patton (1974) reported trees from 11- to 22-in. dbh to be the most used for nesting sites, frequently built from 16 to 90 ft above ground level in trees 20 to 110 ft high. Nests are constructed in branches of large limbs against the bole of the tree or in forks of small branches and are most often found on the

south side of trees (Keith 1965). Pine twigs, 1/2 in. or less in diameter and 6 to 24 in. in length, are used most often as building materials (Keith 1965). Leaves and pine needles are also used (McKee 1941). The inside diameters range from 4 to 10 in. with outside diameters averaging approximately 1-1/2 ft but varying from 1 to 3 ft. Nest bottoms are lined with shredded grass, juniper and pine bark, cloth, string, cotton, and newspaper (Keith 1965). Nest openings vary from one to three; however, one opening occurs most often, especially in nests of female squirrel with young (Keith 1965). Also, Keith found that nest structure varies with the season. Summer nests possess thin walls in comparison with the thick, heavy walls of the winter nests. In early summer, nests appear to have been rebuilt with thinner twig layers; and during warmer summer periods, squirrels are reported to remove the roof of their nests (Keith 1965). During breeding season, several different nests may be used by the female and young (Nash and Ramey 1970). When newborn, the young are kept in a small depression in the floor of a fully lined nest. When between three and six weeks old, they are moved to a larger nest with lining only in the bottom and a greater depth below the nest opening; the latter probably prevents the young from leaving or falling from the nest (Keith 1965).

RITUAL REQUIREMENTS:

Little is known of the behavioral habits of Abert's squirrel because of its shy and secretive nature (Nash and Ramey 1970). Males may defend territory during breeding season. In some cases males have been reported to defend a single pine tree (Nash and Ramey 1970). Keith (1965) reported male squirrels accompanying females throughout April and early May. According to Keith (1965), Rice (1957) observed a breeding group in May 1954, which consisted of a single female accompanied by a dominant male with numerous males in pursuit in adjoining trees. The dominant male attended his mate closely, courting her and defending her from approach by his rivals. Subdominant males were repulsed by means of reckless

bouts and chases; however, actual contact in battles never occurred. During courtship, the female ate, groomed, and rested normally, while the male neither ate nor rested, since he was continuously defending his mate from rival males (Keith 1965).

POPULATION STRUCTURE:

Local population increases and decreases in Colorado are apparently related to ponderosa pinecone production. An abundant cone crop occurs every three to four years. In productive years Abert's squirrel populations appear to increase (Keith 1965, Nash and Ramey 1970). Jones (1976) states that squirrel populations are stable presently on the Kaibab National Forest but appear to have declined to a very low level in Grand Canyon. Population densities may vary from one squirrel per 50 acres to one squirrel per 10 acres, depending on the stand size and pine type diversity. Keith (1965) attributes low populations to loss of habitat caused by logging operations and inadequate ponderosa pine regeneration. In Arizona, sex ratios were reported by Keith (1965) for study periods during six different years; of 729 squirrels, 57 percent were males, and 43 percent were females.

REPRODUCTION AND SURVIVAL:

Breeding season begins in April or May but may extend into June (Hall and Kelson 1959, Jones 1976). The gestation period is between 38 and 46 days (Keith 1965). Three to four young are born in April or May, but new litters have occurred as late as October (Cahalane 1961, Hall and Kelson 1959). Hall and Kelson (1959) reported that Abert's squirrels may produce more than one litter each year. At birth, the young weigh approximately 12 g each and average 60 mm in total length (Keith 1965). At seven weeks of age, the squirrels weigh 242 g and begin feeding on mushrooms and inner pine bark in addition to milk. Complete weaning is accomplished at 10 weeks of age; at 15 to 16 weeks of age, their mature size is reached (Keith 1965).

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APPENDIX M: NARRATIVE FOR BLACK BEAR

FAMILY:

Scientific Name: Ursidae (Jones et al. 1973)

Common Name: Bears

SPECIES:

Scientific Name: _Ursus americanus_ (Jones et al. 1973)

Common Name: Black bear

LEGAL STATUS:

The black bear is protected by state game laws throughout its range in the United States (Barnes et al. 1970).

VALUE POTENTIAL, POSITIVE:

The black bear is considered useful for its fur, hide, meat, and sport potential as a big game animal. In national parks, it serves as a major tourist attraction, frequently seen panhandling for food along roadsides (Bailey 1931, Palmer and Fowler 1975). The black bear has been accredited with keeping check on many small species of animals, such as rodents (Palmer and Fowler 1975).

VALUE POTENTIAL, NEGATIVE:

There has been much controversy about the value of black bears as fur and game animals due to their occasional destruction of domestic stock. However, more detailed investigations of livestock depredations have indicated that much livestock, supposedly killed by black bears, was killed by grizzly bears with the remains of their prey finished up by the more harmless black bears (Bailey 1931). Black bears may become troublesome in wilderness camping areas where they raid camps and cabins for easily accessible foods left within their reach by tourists (Schwartz and Schwartz 1959). The black bear may damage cultivated corn crops and beehives in times of natural food shortages (Lowery 1974).

DESCRIPTION:

"A medium-sized bear with long soft fur. Color: black, blackish rust, or dark brown to pale cinnamon; muzzle brownish; large white spot on chest. Total length, 4-1/2 to 6-1/2 feet; height at

shoulder, 25 to 40 inches; weight, usually 200 to 300 pounds, up to an exceptional 500 pounds. Females are usually about 20 percent smaller than males" (Cahalane 1961). The dental formula is I 3/3, C 1/1, P 4/4, M 2/3, with a total of 42 teeth (Schwartz and Schwartz 1959). "...can be confused only with the grizzly, which has high humped shoulders, larger, heavier and blunter head, usually a dished face, and long, broad, slightly curved front claws that generally are rather light-colored. The black bear has a smaller, more pointed head with a straight face profile and lacks a permanent shoulder hump; its front claws are short, narrow, markedly curved, and black or (in the cinnamon phase) dark brown. Black bears are smaller than grizzlies on the average, but a large old black bear may be more bulky than a small adult female grizzly" (Cahalane 1961).

RANGE:

The species was formerly widespread over the forested areas of North America, its range extending into northern Alaska and Canada, including Newfoundland, south to central northern Mexico, including the Mexican Plateau north of Mexico City. Arid portions of eastern Oregon, the Great Basin, western Arizona, southwestern California, and northwestern Mexico were never occupied by the black bear. In many areas, it has been extirpated by human intrusion, its numbers being vastly reduced within the original inhabited regions (Bailey 1931, Lowery 1974).

HABITAT:

Almost all descriptions of black bear habitat emphasize two important requirements: forest conditions and food availability (Bray and Barnes 1967). Heavily forested areas appear to support the largest bear populations, probably because of the potential escape cover, protection during periods of inclement weather, and accessible dens in hollow trees and overturned roots (Cahalane 1961, Palmer and Fowler 1975). Bray and Barnes (1967) reported habitat types used by the black bear, as noted by various authors, in the following list:

Authority	Location	Habitat Types
Erickson (1957)	Michigan	Spring: semiopen forest types with lush grasses, strawberries (<u>Fragaria</u> sp.), and serviceberry; bears also use abandoned homesteads and lumber camps. Summer: areas with fruit-bearing shrubs and small trees are preferred. Fall: upland hardwoods are used heavily; bears also forage in mature oak stands, abandoned homesteads, and lumber camps. Late Fall: conifer and mixed conifer-hardwood swamp areas are preferred.
Knudsen (1961)	Wisconsin	Large forested areas with an abundance of highlands, swamps, and marshes are the best habitats. Mixtures of a variety of shrubs and small trees are also used. Large areas of aspen (<u>Populus</u> <u>Tremuloides</u>) and jack pine (<u>Pinus</u> <u>banksiana</u>) are poor habitats.
Harlow (1961)	Florida	Well-interspersed mixtures of flatwoods, swamps, scrub oak ridges, bayheads, and "hammock" habitats are the best areas.
Soper (1942)	Wood Buffalo National Park (Canada)	The aspen-spruce (<u>Abies</u> sp.) pine forest type of the Alberta Plateau uplands is a preferred habitat type. Bears also use the poplar-spruce (<u>Populus</u> sp.) forest along rivers. Muskeg and salt plain areas are poor habitats.
Gilbert (1947)	Colorado	The largest bear populations are found in the montane and subalpine forests surrounded by the chaparral type of oak brush, serviceberry, and snowberry.
Grinnell et al. (1937)	California	Bears are found primarily in the heavily timbered areas adjacent to the chaparral type.
Stickley (1957)	Virginia	Large stands of mature oak support the largest populations, especially in the fall.

Tische (1961) reported that dry mountain meadows are used by bears

in Montana in the spring due to the availability of spring food items. He found that streambanks, roadsides of spruce-fir types, south-facing slopes, and snowslide areas are preferred foraging sites in both spring and summer. Moist areas, such as creek bottoms, appeared to be favored in the summer and fall months. Huckleberry and whitebark pine stands supported many bears in the early fall. In the late fall, bears used seral and climax stages of spruce-fir types as well as creek bottoms (Tische 1961).

FOOD HABITS:

Although classed as carnivores, black bears are chiefly omnivorous with plant material constituting as much as 95 percent of their total diet (Beatty 1943, Lowery 1974). Rodents, such as mice and squirrels, carrion, fawns or deer, and elk or moose, may be taken occasionally. Insects, insect larvae, and honey are consumed readily when available (Hamilton 1939). Plant foods, such as oak mast, field corn, berries, pine seeds, nuts, and succulent roots, comprise the staple components of the black bear's diet (Bailey 1931, Hamilton 1939, Martin et al. 1951). Martin et al. (1951) and Tische (1961) determined the following food items to be predominant seasonal components of the black bear's diet:

Common Name	Scientific Name	Season Consumed*
Oak (mast)	*Quercus* spp.	F
Chokecherry, wild cherry	*Prunus* spp.	Su
Beech (mast)	*Fagus* sp.	F
Huckleberry, blueberry	*Vaccinum* spp.	SpSuF
Apple	*Malus* spp.	F
Blackgum	*Nyssa sylvatica*	Season unspecified
Grape	*Vitis* spp.	F
Hawthorn	*Crateagus* sp.	Su
Pine (needles, nuts)	*Pinus* sp.	F
Serviceberry (fruit)	*Amelanchier alnifolia*	F

(Continued)

* Season abbreviations: F = fall; Su = summer; and Sp = spring.

Common Name	Scientific Name	Season Consumed
Buffalo berry	Shepherdia canadensis	Season unspecified
Red osier dogwood	Cornus stolonifera	F
Horsetail	Equisetum sp.	SpSu
Angelica	Angelica dawsonii	SpF
Grasses**	Poaceae	SpSu
Sweet ciceley	Osmorhiza sp.	Sp
Clover	Trifolium sp.	Sp
Cow parsnip	Heraculum lanatum	SpSu
Dandelion	Taraxcum offinale	Sp
Woodrush	Lazula glabrata	F
Swamp currant	Ribes lacustre	F
Mountain ash (fruit)	Sorbus sp.	F
Snowberry (fruit)	Symphoricarpus sp.	F
Ants	Formicidae	SpSu

** Volumetric quantities of grasses were less in summer (Tische 1961).

Bray and Barnes (1967) reported results from food habit surveys done by Bennett et al. (1943), Cottam et al. (1939), Gilbert (1953), Murie (1944), and Tische (1961). Stomach and scat analyses were the two major methods of dietary analysis. Major components found in the diet varied with location. In Pennsylvania, wild cherries (Prunus spp.) comprised 52.7 percent of the total food volume during the summer months. Other items, in order of importance, included acorns (Quercus sp.), 12.6 percent; bees and wasps, 11.5 percent; woodchuck (Marmota monax) remains, 15.7 percent; and blackberries (Rubus sp.), 4.6 percent. The most important fall and winter foods were acorns, 36.3 percent; beechnuts (Fagus grandifolia), 31.1 percent; apples (Malus sp.), 10.9 percent; and wild grape (Vitus sp.), 9.2 percent (Bennett et al. 1943). Stomach analyses also indicated the oak and blueberry were the most important food items in West Virginia and Virginia, measuring 52.0 and 17.5 percent of the total foodstuffs, respectively

(Cottam et al. 1939). From the analyses of 48 stomach and scat samples, Gilbert (1953) determined that serviceberry (Amelanchier spp.) was the most important plant food in Colorado, constituting 23.6 percent of the total volume. He reported that plant material comprised 64.5 percent of the bulk diet, with insect and animal material constituting 17.2 and 7.0 percent, respectively. In Yellowstone National Park, Murie (1944), through analyses of scats, found the following volumes: plants, 81.17 percent; insects, 9.13 percent; and mammal remains, 2.05 percent. Approximately 92.35 percent of the total volume was natural foods, with garbage accounting for 6.24 percent. Scats collected in the vicinity of campgrounds contained 89.28 percent natural foods and 10.48 percent garbage (Bray and Barnes 1967).

The five major components found in 288 stomach samples in Washington were wood fiber, skunk cabbage, fungus, and salal (Poelker and Hartwell 1973). Wood fiber made up 24, 29, and 45 percent of the monthly diet, respectively, in April, May, and June but declined to trace elements in July and the following months. Huckleberry, skunk cabbage, and fungus were consumed year round, with maximum percent compositions reaching 30 percent in November for huckleberry, 20 percent in April for skunk cabbage, and 23 percent in September for fungi. Salal was used from June through October, with a maximum usage of 38 percent in September.

According to Bray and Barnes (1967), Tische (1961) conducted a black bear dietary study on the Whitefish Range of Montana collecting a total of 815 scats and 4 stomach samples. Dietary components were divided into the following categories: leaf and stem, blossom, fruit and seed, and animal food. In the leaf and stem category, grasses, sweet ciceley, cow parsnip, angelica, horsetail, clover, and sedge (Cyperaceae) were important components. Blossom types consumed were primarily those of the dandelion, Indian paintbrush (Castilleja spp.), and huckleberry. Huckleberry, whitebark pine, serviceberry, mountain ash, snowberry, swamp currant, red osier

dogwood, and honeysuckle (<u>Lonicera</u> spp.) were found to have the highest volume percentages in the fruit and seed category. Animal foods consisted primarily of insects, especially ants. Hornets (Vespidae) and bumblebees (Bomidea) were two other insects frequently consumed. Volumetric quantities of insect forms, however, were low. Mammal remains were identified to be primarily those of the elk (<u>Cervis canadensis</u>) and the moose (<u>Alces alces</u>). According to Bray and Barnes (1967), Tische (1961) inferred that although black bears may kill an occasional crippled, sick, or fawn cervid, most such remains of which found in scats and stomach samples are the results of carrion feeding and not actual predation by black bears. Other components appearing in scat samples included rodent remains in four samples, bird remains in three samples, and black bear cub remains in one sample.

SHELTER REQUIREMENTS:

During winter months, the same general areas and materials are used for shelter and bedding purposes. However, during the summer months, black bears have no permanent dens for brood or hibernation shelters. Thickets and windfalls near feeding areas provide resting shelters on warm spring and summer days. Young bears spend much time resting in trees, especially when adults are in the vicinity (Bray and Barnes 1967). Adult bears may occasionally sleep in trees on large horizontal limbs during the warmer parts of the day (Beatty 1943). According to Bray and Barnes (1967), Skinner (1923) reported little use of caves and dens during warmer seasons. The majority of bears in Yosemite National Park were reported to bed down on the ground in litters of pine needles and in scratched out hollows less than 1 ft deep (Beatty 1943).

NESTING AND BEDDING REQUIREMENTS:

Black bears bed chiefly in the winter during hibernation and when the young cubs need protection (Palmer and Fowler 1975). Their dens are in a variety of locations, including road culverts, hollow logs or stumps, caves, and tree or ground cavities. In the Smokey Mountain National Park, black bears use cavities formed by decay

of large broken tree limbs from 30 to 60 ft above the ground in oak, hemlock, and maple trees (Pelton and Burghardt 1976). These dens are probably preferred to ground-level dens because they are at a safer distance from humans and their activities. Taylor (1971) reported several denning sites of black bears in Louisiana, with the majority of these sites located in trees (Lowery 1974). Taylor found bears bedded in tupelo gum (Nyssa aquatica), bald cypress (Taxodium distichum), and green ash (Fraxinus pennsylvanica), with the cavity entrances 30, 96, and 8 ft, respectively, above ground level. The distance from base to height in denning trees ranged from 5 to 7 ft. Denning cavities exhibited diameters of 24 in., with proportions for the lower edge of one opening measuring 14 in. wide and 14 ft long (Taylor 1971). Materials used to line bear dens usually consist of an assortment of grass, leaves, twigs, and bark (Cahalane 1961).

Beatty (1943) describes a typical winter den found on Mt. Watkins in Yosemite National Park at an elevation between 7000 and 8000 ft: "The den was located in a living White Fir, 5 feet in diameter, and was reached through a vertical hole in 4 feet deep snow, at the bottom, of which was a horizontal tunnel about 18 inches in diameter which ran into the opening at the tree base."

RITUAL REQUIREMENTS:

Hibernation: Characteristic of the black bear is its winter sleep. During the summer and early fall months, fat is accumulated in preparation for the lean winter months ahead. The black bear does not hibernate in a true sense in that its body temperature and pulse rate remain normal; the respiration rate is more frequent than that of true hibernators, two to five complete respirations per minute (Schwartz and Schwartz 1959, Palmer and Fowler 1975). This period of sleep takes place in a hollow depression in a large tree or log (Palmer and Fowler 1975, Cahalane 1961). In the southernmost portion of its range, the black bear may retire only a few days or a week at a time during the winter. In northern range

areas, however, "hibernation" may extend from mid-October until April or May (Cahalane 1961). Even in the north, periods of deep and light sleep alternate, and on warm days, bears may wander from their winter den. Extent and length of winter inactivity depends mainly on the weather, snowfall, sex, and food availability. Pregnant females tend to den earlier and longer than males (Cahalane 1961).

Territoriality: Being basically solitary in nature, black bears exhibit strong territorial tendencies. Female black bears usually range in an area of approximately a 10-mile radius; males tend to occupy larger areas. Bears indicate their presence by scratching or gnawing the trunk of trees (Schwartz and Schwartz 1959). According to Bray and Barnes (1967), several different tree species are used: yellow and white birch (*Betula* spp.), balsam fir (*Aspen balsamea*), aspen (*Populus tremuloides*), white cedar (*Thuja occidentalis*) and ponderosa pine (*Pinus ponderosa*).

POPULATION STRUCTURE:

Criteria such as sex ratios, age-class distributions, densities, and population estimates are difficult to establish for the black bear because of its secretive and far-ranging nature (Pelton and Burghardt 1976, Poelker and Hartwell 1973). Collins (1973) indicates sex ratios for North Carolina to be approximately equal with 106 males:100 females. According to Collins, Wakefield (1972) noted 96 males:100 females and 117 males:100 females for Pennsylvania 1967 and 1968 harvests, respectively. Miller (1970) reported the ratio as 118.6 males:100 females over a four-year period in New York (Collins 1973). Jonkel and Cowan (1971) indicated sex ratios for captured black bears on the Big Creek Study Area in Montana to be 112 males:100 females. A ratio of 100 males: 108 females was determined in Michigan by Erickson (1964a). Harvests from bear control operations in Washington from 1951 to 1970 yielded 6003 bears, 56 percent males and 44 percent females for a ratio of 100:79 (Poelker and Hartwell 1973). Age-class

distributions for 5880 black bears taken in Washington from 1950 through 1970 were determined to be 4.2 percent cubs, 12.9 percent yearlings, 40.4 percent subadults, and 42.5 percent adults (Poelker and Hartwell 1973). Hartwell and Poelker also reported age-class distribution for 135 black bears in Washington: 6 percent cubs, 12 percent yearlings, 42 percent subadults, and 40 percent adult. Density values for black bear populations were determined to be one bear per square mile in the peripheral areas of the Smoky Mountains National Park with an increase of approximately two bears per square mile in the deeper regions of the park (Pelton and Burghardt 1976). According to Poelker and Hartwell (1973), Erickson et al. (1964) determined that a 400-square-mile study area in Michigan supported an average of 1 bear for each 3.4 square miles, and in one case of intensive trapping during the study, the team captured 23 bears in a 36-square-mile area, which is approximately 1 bear per 1.6 square miles. Jonkel and Cowan (1971) found the density on a Montana range of 80 square miles to be one bear per 1.7 miles from 1959 to 1966 (Poelker and Hartwell 1973). Spencer (1955) reported densities in Maine to average one bear per 5.6 square miles, and Stickley (1961) determined Virginia bear densities to be one bear per square mile (Bray and Barnes 1967). The black bear density in Washington is at or slightly in excess of one bear per square mile of available habitat. The total population estimate for the black bear in Washington is estimated to be between 27,000 and 30,000, and mortality for this population averages between 15 and 18 percent (Poelker and Hartwell 1973).

REPRODUCTION AND SURVIVAL:

The peak of the breeding season extends usually from June through July over the species' entire range (Schwartz and Schwartz 1959). During the breeding season, male and female adults associate with one another; pairs break up soon after mating occurs (Cahalane 1961). The family group, therefore, consists of the female and cubs, with the male remaining solitary. According to Bray and Barnes (1967), Erickson et al. (1964) found both sexes to mature

at approximately 3-1/2 years of age and mature females to maintain a condition of continuous estrus during the breeding season until bred or until ovarian degeneration. Erickson et al. also indicated that lactating female bears fail to exhibit estrus; therefore, pregnancies occur on alternate years. The gestation period is generally seven months, the cubs being born in January or February, commonly during the female winter sleep (Palmer and Fowler 1975, Schwartz and Schwartz 1959). The first litter produced by a female bear usually consists of only one cub, and on alternate years thereafter she commonly produces two cubs per litter, sometimes three and rarely four or five (Cahalane 1961, Palmer and Fowler 1975, Schwartz and Schwartz 1959). At birth, the cubs weigh 6-8 oz, measure 9 in. in length, and are blind, toothless, and covered with extremely fine hair (Cahalane 1961). At two months of age, the cubs weigh 4-5 lb and leave the den with their mother (Morris 1965). At the age of 4 to 5-1/2 months, they are usually weaned and self-sufficient but remain with the female until the following fall (Morris 1965).

Fifteen years is probably the average life span for the black bear in the wild; however, in captivity it may live up to 30 years (Lowery 1974). Palmer and Fowler (1975) report the life span to be 25 years. In a population study conducted by Collins (1973) in North Carolina, canine teeth collected during the 1969, 1970, and 1971 hunting seasons revealed average ages of 5.17, 4.73, and 4.82 years, respectively. Average ages increased in coastal zones but decreased in the mountainous regions. Total age groups collected ranged from 0.75 to 22.75 years. Yearlings, 1.75 years old, represented 29 percent of the seasonal kills, with a high incidence of young males. Yearlings and 2.75-year-old males constituted the bulk of the annual harvest. Age classes from 3.75 to 20 years were predominantly females. This indicated that young males are more vulnerable to hunting because of the tendency to wander in search of food. According to Collins (1973), Stickley

(1961) reported that males moved much more than females and that yearling males move almost as much as adult males. In the Smoky Mountains, Pelton and Burghardt (1976) found 70 percent of the bears within national park boundaries were adults, 45 years or older, but only 40-50 percent reached this age outside the park (probably because of hunting tolls). In Washington, the average age values from a group of 135 bears were 3.7 years for males and 6.6 years for females, with 4.7 years the average age of the entire group. The maximum age recorded for males was 14 years and for females was 27 years (Poelker and Hartwell 1973).

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APPENDIX N: NARRATIVE FOR BLACK-FOOTED FERRET

FAMILY:

Scientific: Mustelidae (Snow 1972)

Common: Weasel

SPECIES:

Scientific: _Mustela nigripes_ (Snow 1972)

Common: Black-footed ferret

LEGAL STATUS:

The black-footed ferret is now protected as an endangered species throughout its range (Federal Register 1967 and 1970).

DESCRIPTION:

The black-footed ferret is weasellike with short legs, well-developed front claws, and relatively large ears and eyes. Ferrets weigh between 1-1/2 and 3-1/2 lb. Adult males average 21-23 in. in total length, including the tail. The female adults are usually approximately 10 percent less in total length. The most striking feature of the black-footed ferret is its black face mask. The feet, leg-shoulder area, and terminal tip of the tail are also black. The remaining coloration of the pelage is primarily a pale yellow buff, becoming lighter on the underparts and whitish on the forehead, muzzle, and throat. The dorsal head and midback are brown. The fur length on the back is approximately 2/5 in.; winter pelage is slightly longer (Snow 1972). A pronounced black to black-brown longitudinal strip in the public region usually occurs in males but may be found in females also as a lighter marking. Males are slightly lighter than females, and young ferrets are lighter than adults (Henderson et al. 1974, Snow 1972).

RANGE:

The black-footed ferret exists in very limited numbers over most of its former range: Montana, Wyoming, Colorado, New Mexico, Arizona, Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota (Snow 1972).

HABITAT:

The ferret lives chiefly in prairie dog (genus Cynomys) towns, using the rodent as a major food source and its burrows as shelter (Hall and Kelson 1959). Both species inhabit the short and mid-grass prairies occurring from Alberta and Saskatchewan south to Arizona and Texas (Henderson et al. 1974). In South Dakota, Henderson (1974) reported that the black-footed ferret inhabits the colonies of the black-tailed prairie dog. In the western portion of the state, these towns are on gentle slopes or level ground of clay and silt soils, primarily of the Chestnut zonal group (Henderson et al. 1974). Average precipitation ranges from 13 to 19 in. annually, and short grasses, such as buffalo grass, wheatgrass, blue grama, and needlegrass, are predominant on this soil type (Henderson et al. 1974, Hillman 1968). Ferrets have been found in haystacks, under buildings, and in ground squirrel colonies (Henderson et al. 1974, Snow 1972). Henderson et al. (1974) concluded that ferrets observed here were merely migrating through these areas.

FOOD HABITS:

The prairie dog is the black-footed ferret's major food source. Overexploitation of these rodents may be partially responsible for the ferrets' population decline in past years (Allen 1942, Henderson et al. 1974). Ferrets usually kill prairie dogs in underground burrows by attacking them at the throat region or nape of the neck (Henderson et al. 1974, Hillman 1968). Ferrets generally return to their own burrow to consume their prey. Aldous (1940) observed that captive ferrets ate the greater omentum of the intestine, the liver, and the heart of a prairie dog (Henderson et al. 1974). D. R. Progulske (in Henderson et al. 1974) reported that one ferret consumed only the muscle, bones, and other organs of the neck region of several prairie dogs. In two instances, the amount consumed ranged from 1/4 to 1/3 lb. Another male ferret in captivity consumed 60 to 364 g of meat daily (Henderson et al. 1974, Snow 1972). Scat sample analyses were reported by several

authors (Henderson et al. 1974, Hillman 1968, Linder et al. 1972). Prairie dog components were prevalent in all cases. Examination of one dropping collected in Mellette County, South Dakota, as well as two scats collected by Hillman (1968) consisted entirely of prairie dog bones and hair (Henderson et al. 1974). Ferret droppings recovered from prairie dog burrows by Sheets et al. (1971) contained remains of prairie dogs (91 percent frequency) and mice (26 percent frequency) (Linder et al. 1972). Sheets and Linder (1969) excavated six burrows occupied by a female and four young and found skulls, feet, and skins of prairie dogs and 56 scats. Of the 56 scats, 51 contained prairie dog remnants, and 19 contained mouse remains (Snow 1972). Of the animal material present, prairie dog and mice remains represented 82 and 88 percent, respectively (Snow 1972).

The fact that ferrets have, on occasion, been found in haystacks, near buildings, and in close proximity to animals other than prairie dogs is evidence that they can subsist for some time on alternative food sources; however, they apparently will not do this indefinitely (Henderson et al. 1974). Potential prey of the ferret includes thirteen-lined ground squirrels (Citellus tridecemlineatus), pocket gophers (Geomys bursarius), deer mice (Peromyscus spp.), cottontail rabbits (Sylvilagus floridanus), upland plovers (Bartamia longicauda), horned larks (Eremophilia alpestris), western meadow larks (Sturnella neglecta), and snakes (Hillman 1968). Furthermore, Hillman indicated that ferrets were never observed to prey on animals other than prairie dogs except those made available for experimental studies. In captivity, ferrets will accept commercial mink food, fish, liver, hamburger, pork, milk, rabbit, and bread (Snow 1972).

SHELTER REQUIREMENTS:

The black-footed ferret depends on abandoned burrows of the prairie dog for shelter. These burrows provide a moderate environment protecting the ferrets from predators and inclement weather

conditions (Snow 1972). A burrow consistently occupied in South Dakota by ferrets angled downward about 60 deg from horizontal for about 2 ft and then dropped straight down for 8 ft before leveling off (Henderson et al. 1974).

NESTING AND BEDDING REEQUIREMENTS:

Ferrets birth and rear their young in prairie dog burrows (Henderson et al. 1974). Ferret families frequent all parts of the towns (Hillman 1968). Hillman noted that in South Dakota some burrows were used more than others, especially before young were moving about on their own, but that none appeared to be a permanent den. One burrow was mostly occupied by young ferrets in early July. By early August, the mother relocated them in separate burrows throughout the town. Usually the ferrets would emerge from the same burrow entrance they originally entered, but on occasion when burrows were in close proximity, the ferrets would reappear from a different burrow (Hillman 1968).

RITUAL REQUIREMENTS:

Very little is known of the life history of the black-footed ferret; therefore, detailed information on behavioral rituals is not available (Snow 1972). Henderson et al. (1974) reported that ferrets usually urinate at the openings of burrows. An experiment was conducted in which a stuffed ferret was placed at the entrance of a burrow that a ferret had entered. Subsequent examination indicated that the ferret had urinated on the board on which the stuffed ferret was mounted. Urination in this case may be a means of territorial marking or dominance display.

Both young and adults are nocturnal. Most hunting and feeding activity occurs at night. In family groups, the female cautiously surveys the area and then retrieves her young from their burrows.

Trenching is diagnostic of the ferret. When excavating in a burrow, the ferret backs out with the dirt held against its chest with its front paws, each time dragging the dirt farther from the burrow entrance. As a result of this continuous digging, a trench from

3 to 5 in. wide and from 1 to 9 in. long is formed (Henderson et al. 1974).

POPULATION STRUCTURE:

Presently the general conclusion is that the black-footed ferret has never been abundant (Snow 1972). However, due to man's efforts to poison prairie dogs and to change land use, ferret populations have declined abruptly (Henderson et al. 1974). Most ferret sightings to date have been in South Dakota. From 7 August 1964 through 1967, 82 records of ferret sightings were documented by Henderson et al. (1974). Twenty one of these observations were made by Hillman (1968) at six different localities in southwestern South Dakota between April 1966 and September 1967. All sightings occurred on prairie dog towns from 15 to 100 acres in size. From the first report in 1889 until 7 August 1964, 213 individuals were recorded for South Dakota. In 1970, reports on ferret sightings came from Colorado, Utah, Nebraska, Montana, and New Mexico; the last sighting in Wyoming was recorded in 1965 (Henderson et al. 1974, Snow 1972). In 1972, the New Mexico Game and Fish Department indicated that the ferret was probably extirpated in New Mexico; Cahalane reported two ferret sightings in Texas in 1953 (Henderson et al. 1974). Statistical data on ferret populations are not available presently (Henderson et al. 1974, Snow 1972).

REPRODUCTION AND SURVIVAL:

The most comprehensive information on reproduction of this species has been documented by Henderson et al. (1974) as follows: The breeding season is believed to begin in April or May; using the 42-day gestation period of the closely related ferret fitch, birth of the young would occur in May or June. Additional data were obtained from killed females. One female killed on 16 May 1967 appeared to be in heat. A female trapped on 3 May 1920 was reported to be pregnant. On 20 June 1913, a nursing female was trapped. A litter of one-third grown ferrets with partially open eyes was observed on 6 July 1967 (Henderson et al. 1974). Litters commonly consist of four young, although litters of three, five,

or more have also been reported. The ferret has three pairs of mammary glands. The female rears the young alone; however, the male may remain in the vicinity of the family. A female observed in South Dakota from June to mid-July localized her young in the same general area of a prairie dog town. In mid-July after the young became more active, the family extended its area of activity and increased its frequency of relocation perhaps in response to greater activity and increasing food demands of the growing young. Weaning appeared to occur in mid-July, the young exhibiting one half their adult size. By early August, the female began separating the young into different burrows. During this time, they were observed hunting alone. By late August or early September, the ferrets were independent and adult size; dispersion of the family group began. Early fall is the principal dispersal period for the black-footed ferret. Of 70 ferrets found dead or observed outside of prairie dog towns, 43 percent were noted between mid-August and mid-October. Mortality is perhaps highest during dispersal of family groups, with many individuals being killed on highways. Sport shooting, trapping, and poisoning of prairie dogs also result in heavy losses in ferret populations (Henderson et al. 1974, Snow 1972). Widespread use of strychnine and sodium monofluoroacetate to poison prairie dogs reduces the ferret's food supply and also causes secondary poisoning in the predator (Hillman 1968). Possible enemies of the ferret include badgers, domestic dogs, coyotes, domestic cats, owls, bobcats, prairie rattlesnakes, hawks, and eagles; however, man probably causes most mortality (Snow, 1972).

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APPENDIX O: FORT CARSON HABITAT IMPROVEMENT METHODS

1. The Land Management Branch, DFAE, has improved the wildlife habitat on Fort Carson by managing two aspects (water and food) of the four general habitat requirements of wildlife (food, cover, water, and space). Management personnel have increased the number of water sources and planted forage plant species in selected areas of Fort Carson as described below.

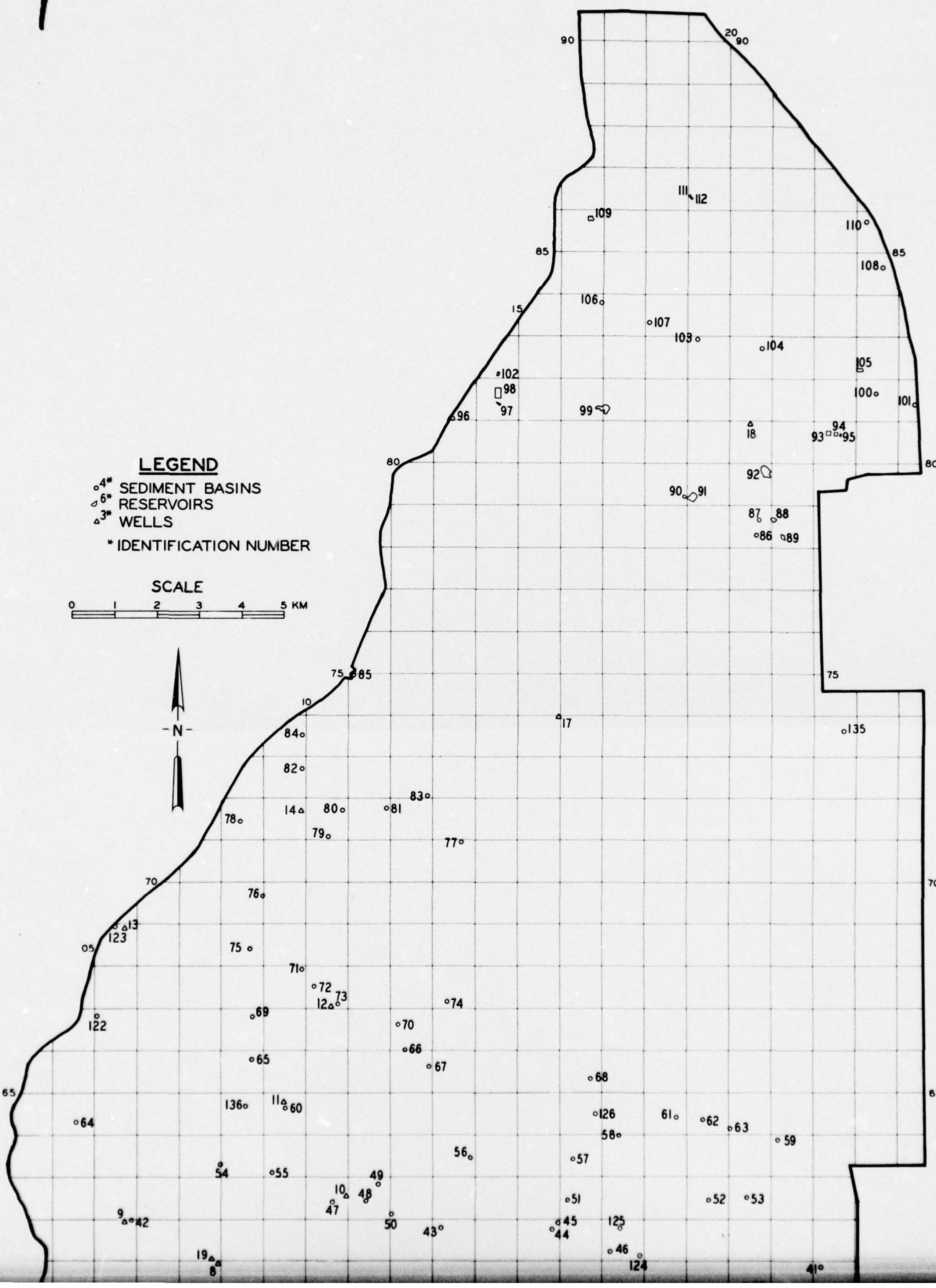
Water Sources

2. Several permanent and temporary water sources for wildlife have been developed on Fort Carson. Permanent water sources include reservoirs (Teller, Haymes, Townsend, North Side, Fountain, and 12 others unnamed) and wells (18 total). Temporary water sources consist of 139 sediment basins that fill with rainwater during the rainy season (July to September). A list of impoundments (reservoirs and sediment basins) indicating their locations and approximate water surface areas at capacity is presented in Table O1. The locations and storage capacities of the wells are presented in Table O2. The locations of these water sources on Fort Carson are shown in Figure O1.

3. The two methods that Fort Carson used to develop water sources were to build sediment basins and to restore existing wells to operating condition. The construction of sediment control structures (sediment dams and their associated basins) is described in report 3 of this series. All 18 wells (14 windmills and 4 electric pumps) were restored in 1975, but eight of these are without storage or stock tanks accessible to wildlife (Table O2). Restoration procedures included replacement of mechanical parts and redrilling the wells and rehabilitating the storage and stock tanks. Figure O2 shows a rehabilitated windmill with water storage and stock tanks.

Food Sources

4. In 1975, Fort Carson conducted two experimental wildlife


LEGEND
4* SEDIMENT BASINS
6* RESERVOIRS
3* WELLS
* IDENTIFICATION NUMBER
SCALE
0 1 2 3 4 5 KM
N

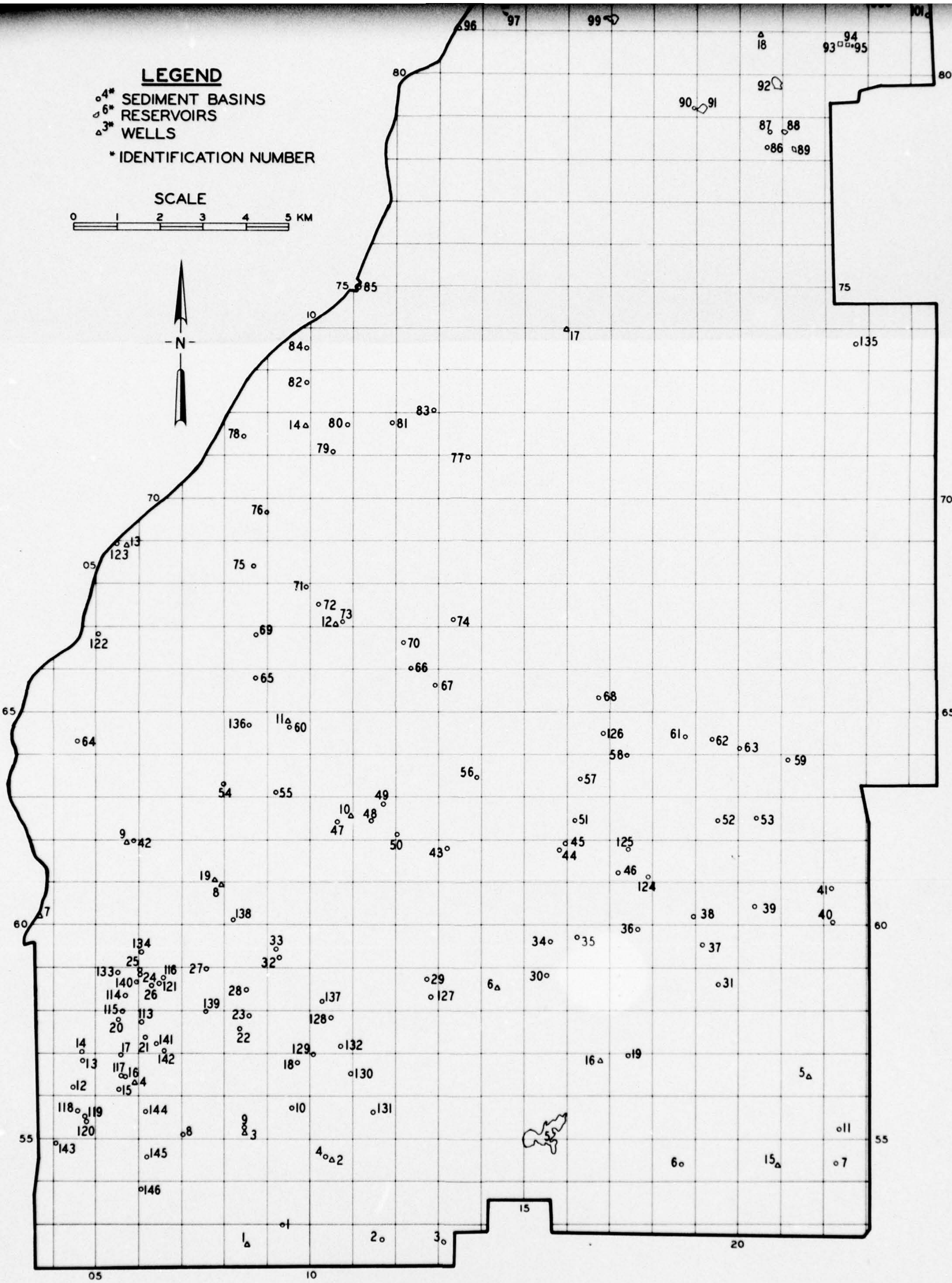
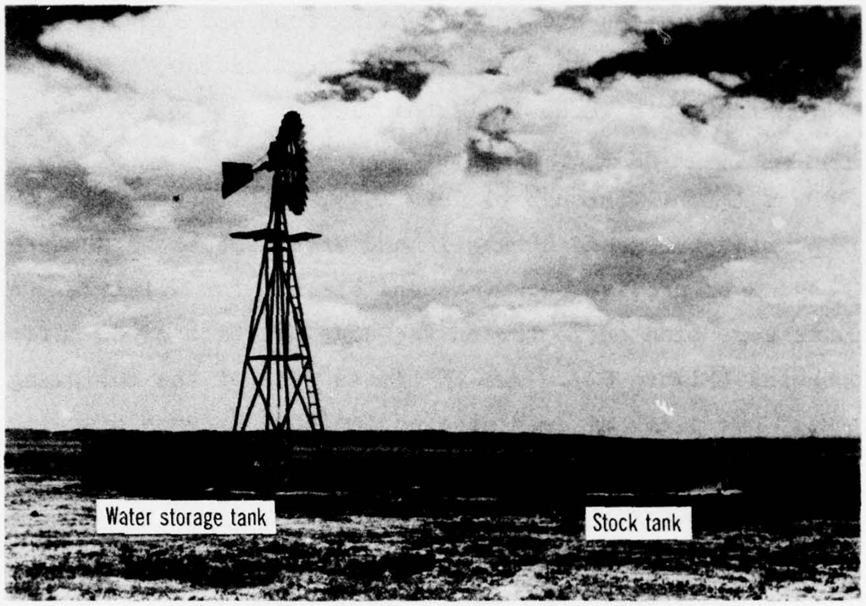
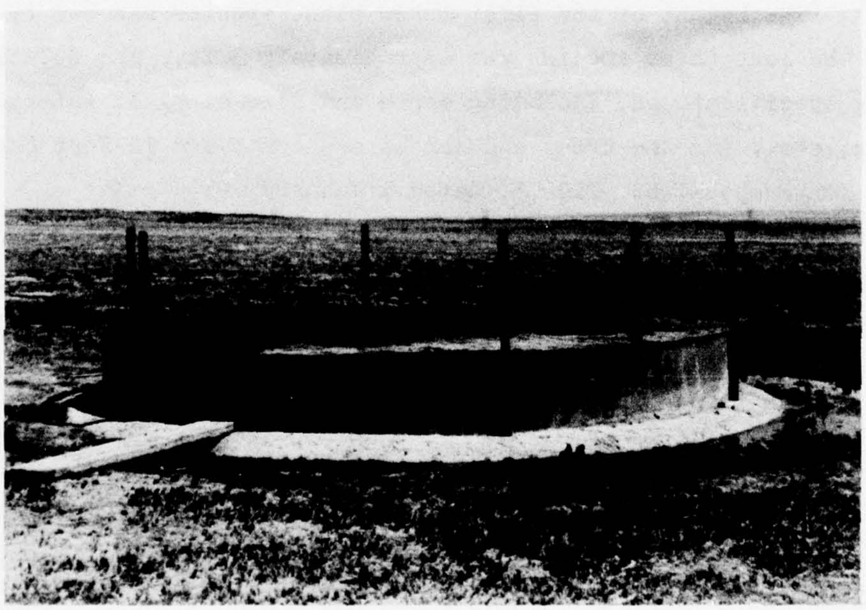


Figure 01. Location of water resources on Fort Carson

2



a. Windmill and water storage and stock tanks



b. Stock tank

Figure 02. Rehabilitated windmill with water storage and stock tanks (military coordinates 10545452)

planting programs: trees and shrubs having food and shelter value for wildlife were planted around 30 of the sediment basins, and legumes and grasses were planted in three irrigated fields.

Tree and shrub plantings

5. From 1 April through 31 July 1975, Fort Carson land management personnel planted trees and shrubs in and around selected downrange sediment basins to provide both food and shelter for wildlife. A total of 15 plants were planted in (or on the edge of) each of 30 different sediment basins (Figure 03). The 15 plants were of the following species with at least one plant of each species included in each planting:

a. Russian olive (*Elaeagnus augustifolia*).

b. Hackberry (*Celtis occidentalis*).

c. Honey locust (*Gleditsia triacanthos*).

d. Cotoneaster (*Cotoneaster acutifolia*).

e. Sand cherry (*Prunus besseyi*).

f. American plum (*Prunus americana*).

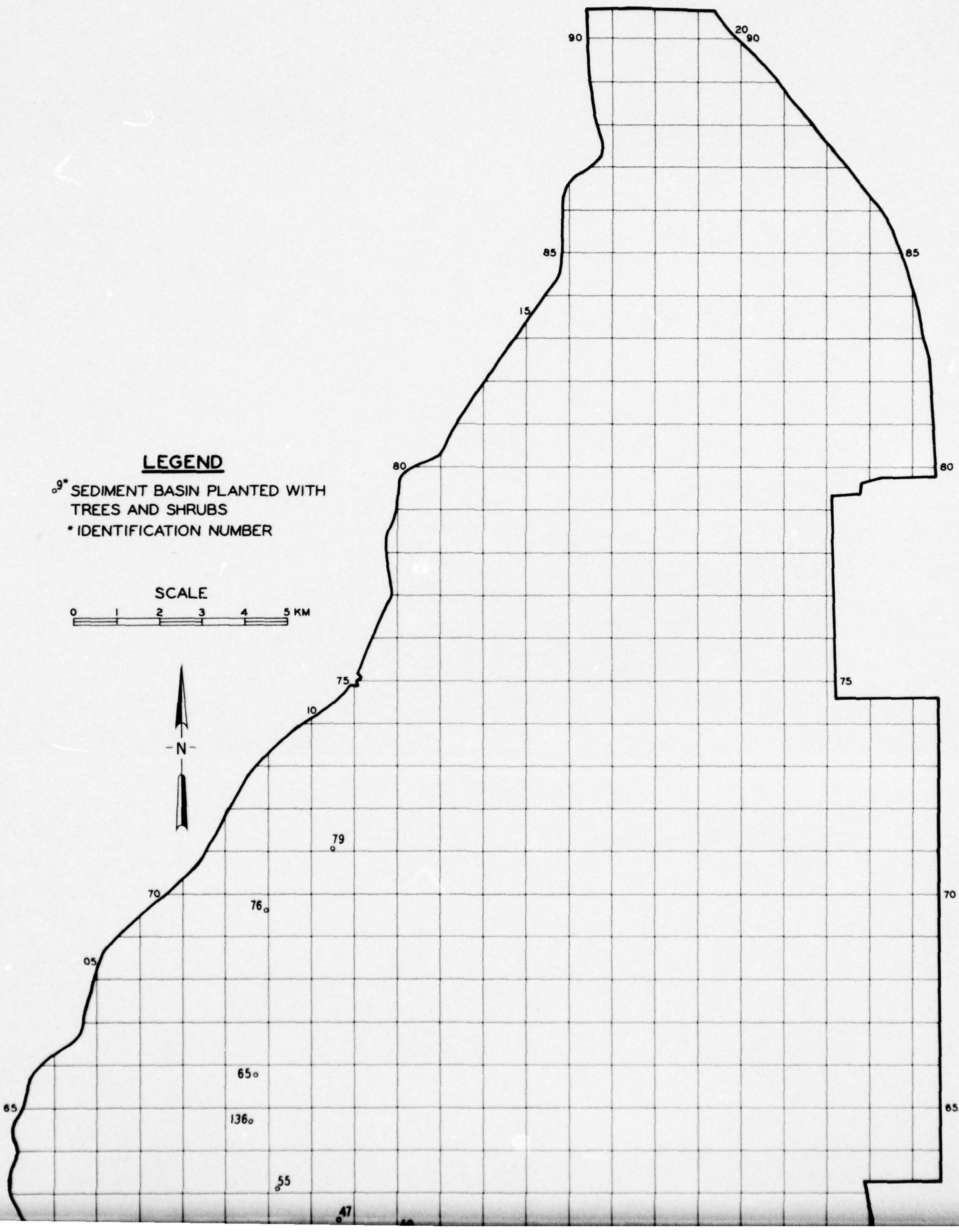
The number of trees and shrubs planted in 1975 was 450 (75 of each species). The height of the first three plant species was 6-8 ft, and that of the last three species was approximately 3 ft. The detailed planting specifications, including depth and size of pits, watering, mulching, etc., for the trees and shrubs are contained in Fort Carson's Request for Proposal No. 119-75, dated 1 January 1975.

6. The effectiveness of the tree and shrub plantings to provide food and shelter for wildlife cannot be determined until the trees and shrubs have reached reproductive maturity. At that time, the fruits and berries of the plants will be available for food, and the plants will have matured enough to be large enough to provide cover. Reproductive maturity is expected in two to five years for the species planted.

Experimental irrigation fields

7. During 1975, facilities engineering personnel also conducted an experimental program to determine the potential for increasing the productivity (i.e. vegetation mass density) of legumes and grasses (forage) important to wildlife on a portion of rangeland under irrigation. Potential productivity was determined by planting the grasses

1


LEGEND
o9* SEDIMENT BASIN PLANTED WITH TREES AND SHRUBS
* IDENTIFICATION NUMBER
SCALE
0 1 2 3 4 5 KM
N
90
20
90
85
15
85
80
80
75
10
75
79
70
70
76
05
65
65
136
65
55
47

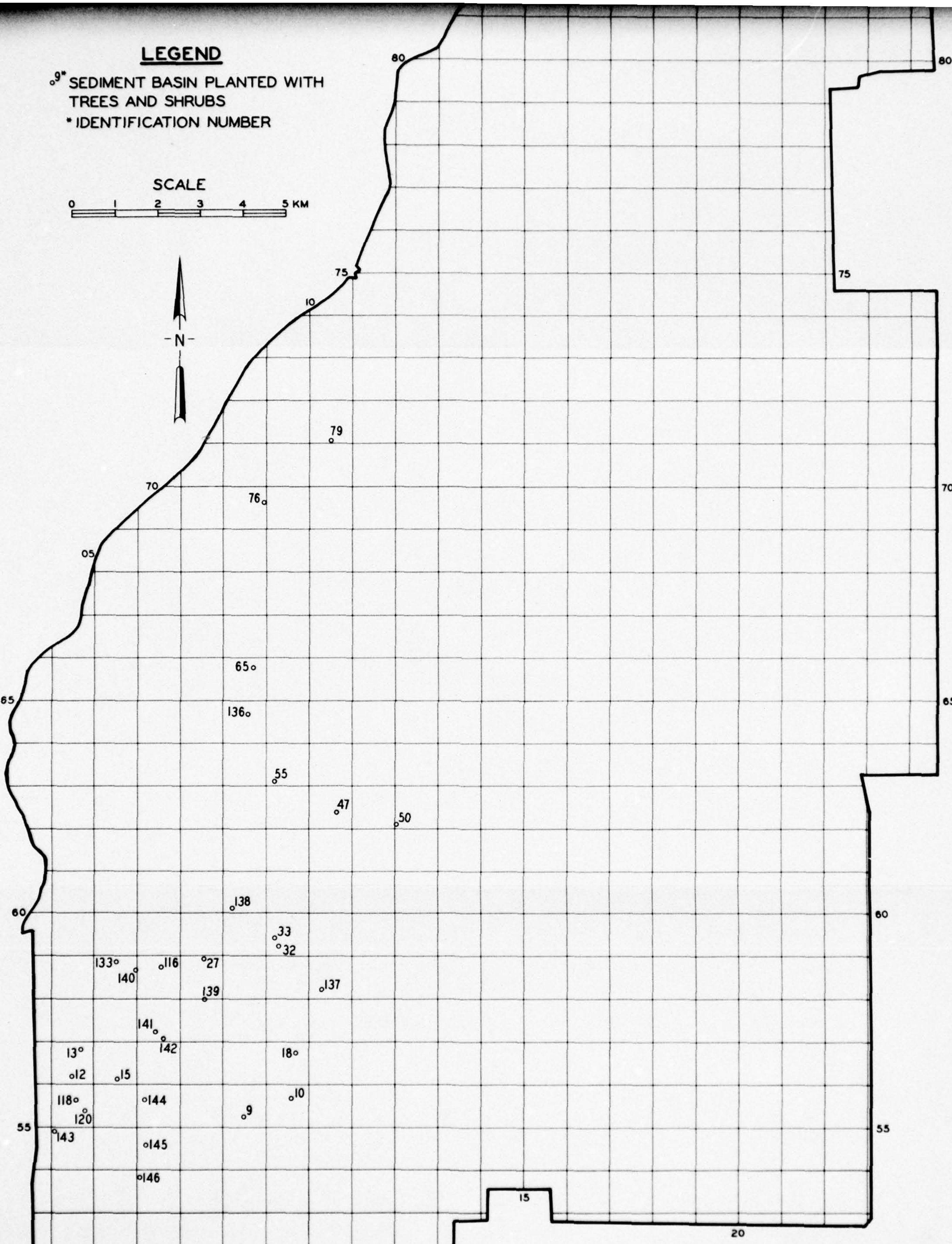


Figure 03. Location of sediment basins on Fort Carson that were planted with trees and shrubs

7

and legumes in an area that was subsequently irrigated and by harvesting the forage to determine the productivity. This particular area is adjacent to the installation Rod and Gun Club (Figure 04) and could

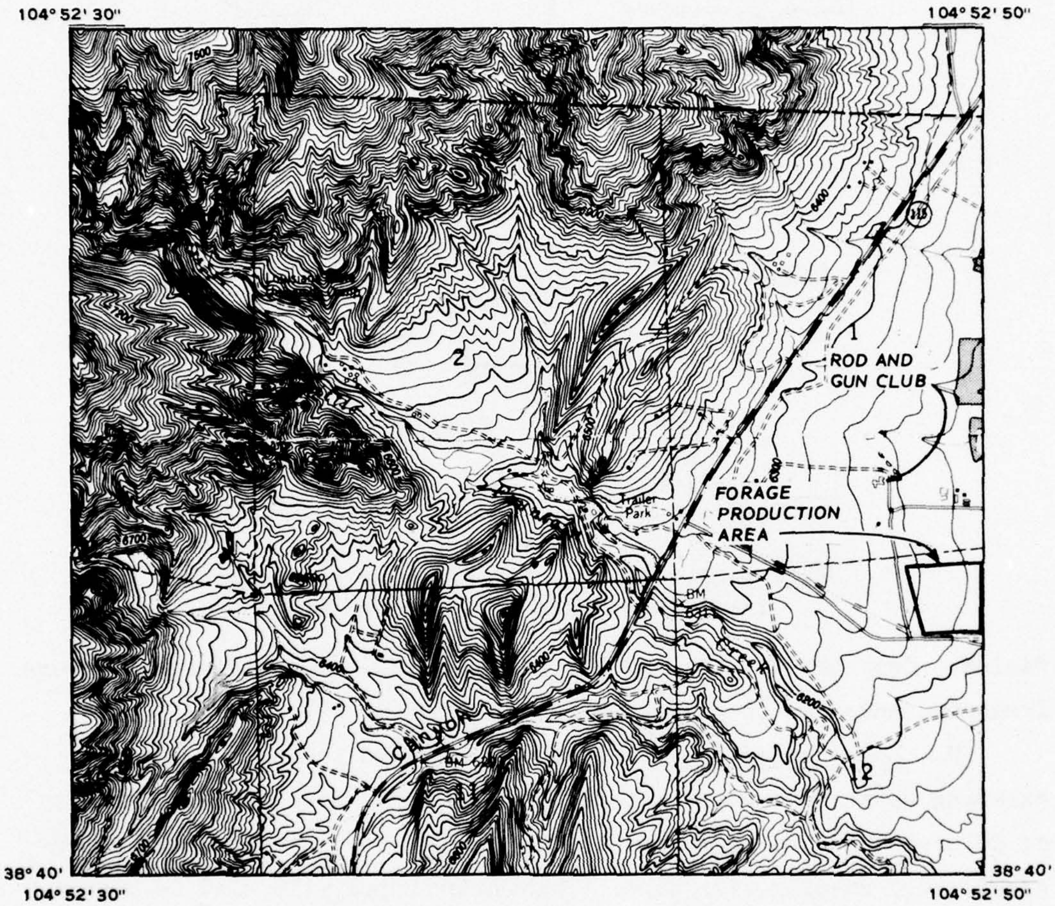


Figure 04. Location of area used for experimental forage production (1:24,000-scale map)

potentially yield high vegetation productivity as a result of use of an existing underground piped irrigation system (Figure 05).

8. The irrigation system consists of an underground tile pipe, concrete box outlets, and small lateral irrigation ditches and dikes. Figure 05 shows the basic layout of the irrigations system and the location of the ditches and dikes that separate the individual irrigated

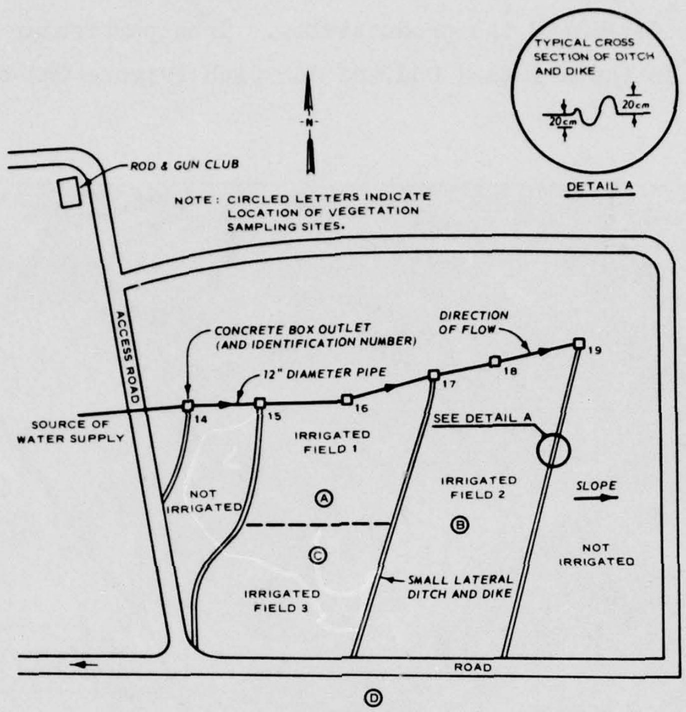


Figure 05. Layout of irrigation system and fields and dikes for growing forage

fields. Only three of the fields (fields 1, 2, and 3, Figure 05) were irrigated and used in the experimental program.

9. Underground pipe. Water was supplied to the system from existing water reservoirs off post, which were maintained by the city of Colorado Springs and piped to the irrigation system through underground 30.5-cm-diam tile pipe. This water supply (15 cfs) is continuously supplied to the post under adjudicated water rights of the State of Colorado (water rights appropriated by the state to a certain land owner).

10. Concrete outlet boxes. Water is distributed from the underground pipe to the lateral irrigation ditches and dikes by blocking the flow of water through the concrete box outlets (a board is placed over the outlet pipe). This causes the water to overflow the concrete box (Figures 06 and 07) and enter the lateral ditch (only one field is irrigated at a time).

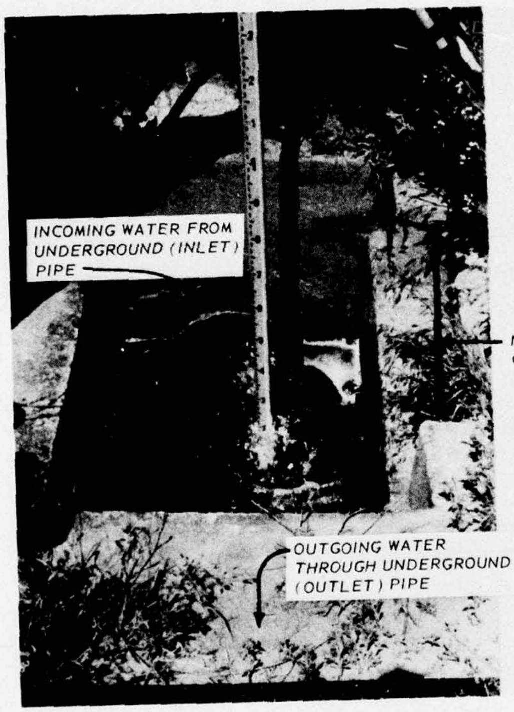
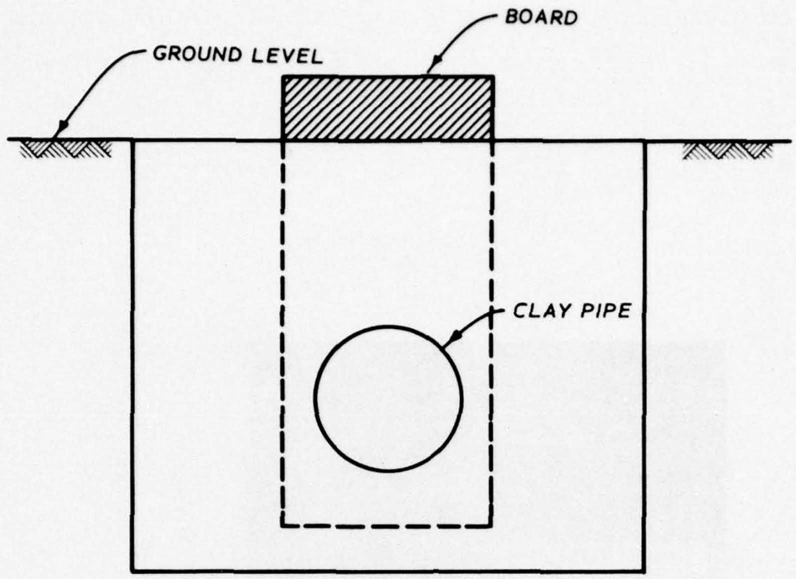
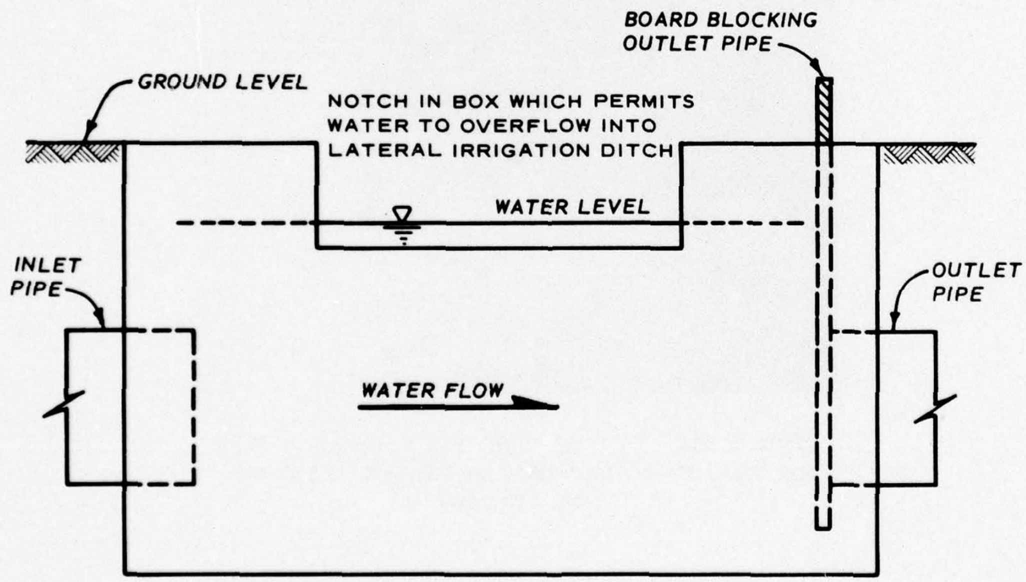


Figure 06. Underground pipe and concrete box outlet of irrigation system (system not in use)



a. VIEW OF OUTLET BOX PARALLEL TO FLOW



b. VIEW OF OUTLET BOX PERPENDICULAR TO FLOW

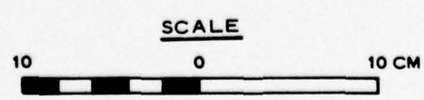


Figure 07. Concrete box outlet of irrigation system (system in use)

11. Lateral ditches and dikes. The lateral ditches and dikes were used to distribute the water over the fields. The ditches carried the water and the dikes retained the water until the field was flooded to a depth of 2-3 cm (see insert Figure 05). Two methods were used to breach the dikes on the downslope side of the ditches. Method one used 30- to 60-cm lengths of plastic water pipe, which were inserted through the dike (Figure 08a). Method two used a cut in the dike to distribute the water from the lateral ditch (Figure 08b). In order to increase the water depth in the ditches, canvas dams (made from 2 by 4 by 60-in. board and 48 by 60-in. canvas) were used to dam the lateral ditches (Figure 09). The board was placed across the ditch and the canvas draped over it. The upstream side of the canvas was weighted down with earth. The canvas dike blocked the flow of water down the ditch and thus increased the flow of water from the ditch onto the fields. A hole was cut in the canvas to allow the water to flow to the next canvas dam. Several of the canvas dams were placed in series down the length of the ditch.

12. Prior to planting (November 1975), the fields were disked and smoothed with a heavy wooden beam. Small lateral irrigation ditches were constructed along the west side of the dikes. The various fields (Figure 05) were then seeded (December 1975) with different forage species as listed below:

Field	Species	Seeding Rate lb/acre
1	Clover (Alsike)	4
	Brome (Manchar)	4
	Intermediate wheatgrass	4
2	Alfalfa (Ranger)	10
3	Alfalfa (Ranger)	3
	Orchard grass	4
	Brome (Manchar)	6

13. The fields were irrigated six times a year during the growing season (May-September) and harvested three times a year during the summer and fall. On 1 June 1976, these three fields (Figure 05) were

a. Plastic pipe distribution method

b. Dike-cut distribution method

Figure 08. Methods of distributing water from the lateral ditches to the fields

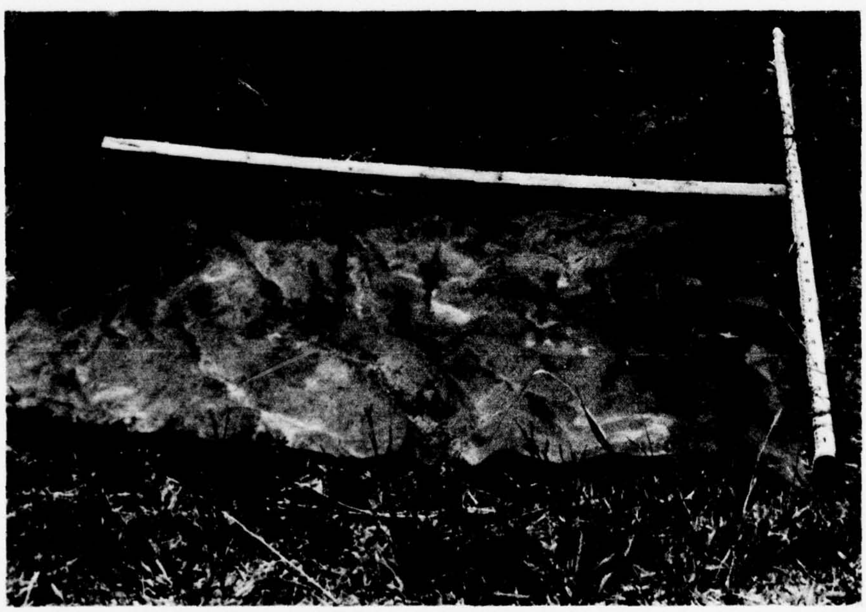


Figure 09. Canvas dam used to increase the water depth in the lateral ditches

first harvested, and the following production was obtained:

Field	Size acres	Green Production of Forage tons/acre	Total Production of Field, tons
1	3.1	2.92	9.1
2	10.0	1.62	16.2
3	6.5	1.00	6.5

14. On 28 June 1976 (approximately four weeks after the first harvest), a WES field team (Figure 010) visited the areas to obtain detailed data on plant densities and coverages and surveyed data on the fields and irrigation system. Those data are presented below.

Vegetation data

15. The vegetation within the field and sample locations (Figure 05) is described in terms of vegetation type, density (number of stems per 2500-cm^2 area), and ground areas of plant coverage in the following tabulation:

Field and Sample Locations	Vegetation Type	Density, Number/ 2500 cm^2	Plant Coverage, %
1 (A)	Clover (Alsike)	26	10
	Brome (Manchar)	100	10
	Intermediate wheatgrass	125	10
2 (B)	Alfalfa	85	95
3 (C)	Alfalfa (Ranger)	34	30
	Orchard grass	100	10
	Brome (Manchar)	100	5
Adjacent non-irrigated field (D)	Red three awn	25	10
	Lamb's-quarters	20	5

Figures 011 through 014 are ground photographs showing the stages of growth four weeks after the first cutting.

Topographic data

16. A detailed ground survey of the fields, ditches, dikes, and water irrigation system was performed by the WES and the results are presented in Table 03.

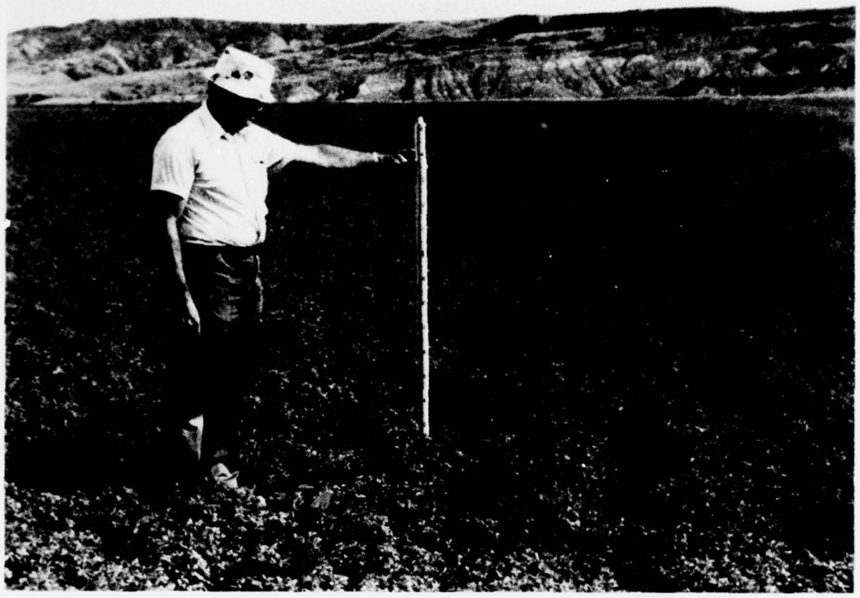


Figure 010. WES field team collecting ground survey data in forage fields

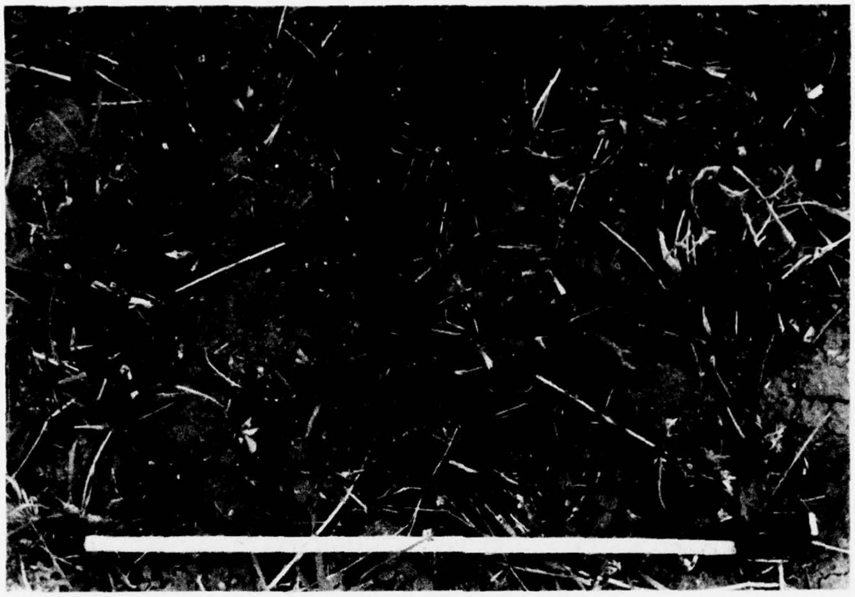


Figure O11. Sample site A in irrigated field 1 as shown in Figure P4. Four-week-old vegetation consists of approximately 30 percent plant cover of clover, brome, and intermediate wheatgrass (29 June 1976)

Figure O12. Sample site B in irrigated field 2 as shown in Figure P4. Four-week-old vegetation consists of 95 percent plant cover of alfalfa (29 June 1976)

Figure O13. Sample site C in irrigated field 3 as shown in Figure P4. Four-week-old vegetation contains approximately 45 percent plant cover and consists of alfalfa, orchard grass, and brome (29 June 1976)

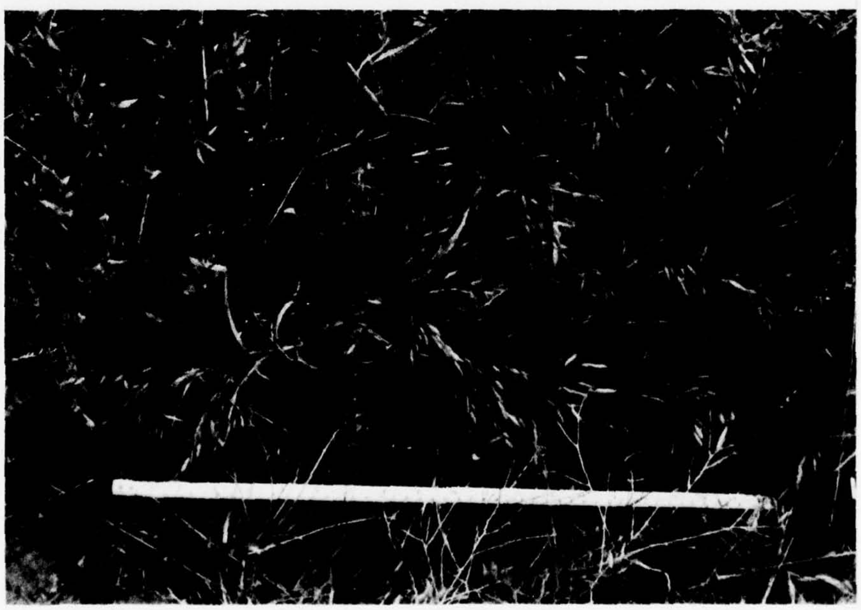


Figure O14. Sample site D in area adjacent to irrigated fields as shown in Figure P4. Vegetation consisted of a mixture of naturally occurring grasses and annual weeds (29 June 1976)

Table 01

Characteristics of Impoundments*

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
1	09385292	10,483	Sediment basin
2	11705258	8,870	"
3	13355213	5,645	"
4	10375449	5,645	"
5	15185469	374,999	Teller Reservoir
6	18695437	8,870	Sediment basin
7	22305438	9,677	"
8	07025503	11,290	"
9	08485523	6,451	"
10	09565568	9,677	"
11	22395518	9,677	"
12	04475615	6,451	"
13	04695675	4,032	"
14	04705699	5,645	"
15	05555609	5,645	"
16	05685642	4,032	"
17	05575689	10,483	"
18	09705670	6,451	"
19	17445687	7,258	"
20	05525772	2,419	"
21	06145731	5,645	"
22	08355752	6,451	"
23	08565781	6,451	"
24	06015879	8,064	"
25	06015889	4,032	"

(Continued)

* Blanks indicate no data.

(Sheet 1 of 6)

Table 01 (Continued)

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
26	06285853	5,645	Sediment basin
27	07555890	8,870	"
28	08515843	9,677	"
29	12735867	6,451	"
30	15535878	8,064	"
31	19555860	5,645	"
32	09285920	10,483	"
33	09205939	4,838	"
34	15625958	6,451	"
35	16295969	10,483	"
36	17675984	18,548	"
37	19215949	13,709	"
38	18996016	3,225	"
39	20436038	12,903	"
40	22226003	9,677	"
41	22216082	20,967	"
42	05906194	10,483	"
43	13166179	7,258	"
44	15856172	5,645	"
45	15996188	6,451	"
46	17226116	4,032	"
47	10646236	13,709	"
48	11476240	26,612	"
49	11726275	11,290	"
50	12026208	18,548	"

(Continued)

(Sheet 2 of 6)

Table 01 (Continued)

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
51	16186238	4,838	Sediment basin
52	19516238	4,032	"
53	20496248	5,645	"
54	07986327	14,516	"
55	09186310	19,354	"
56	13886345	8,064	"
57	16276339	19,354	"
58	17456395	10,483	"
59	21216389	21,774	"
60	09536457	11,290	"
61	18766438	15,322	"
62	19406433	9,677	"
63	20046409	14,516	"
64	04526421	4,838	"
65	08726576	3,225	"
66	12366598	9,677	"
67	12926556	10,483	"
68	16756529	13,709	"
69	08736677	3,225	"
70	12156655	11,290	"
71	09906789	8,064	"
72	10196748	3,225	"
73	10756703	9,677	"
74	13346708	8,870	"
75	08686835	13,709	"

(Continued)

(Sheet 3 of 6)

Table 01 (Continued)

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
76	08956963	8,064	Sediment basin
77	13677092	9,677	"
78	08487144	5,645	"
79	10507103	15,322	"
80	10857169	4,383	"
81	11927165	18,548	"
82	09887268	6,451	"
83	12867201	7,258	"
84	09937347	5,645	"
85	11057499	16,935	"
86	20657823	2,419	"
87	20757863	4,838	"
88	21067858	12,903	Reservoir
89	21337825	8,870	"
90	18967914	6,451	"
91	19117909	33,870	Haymes Reservoir
92	20917962	40,322	North Side Reservoir
93	22378065	10,483	Fountain Reservoir
94	22558064	9,677	"
95	22668062	2,419	"
96	13408101	3,225	Sediment basin
97	14548135	13,709	Reservoir
98	14458149	29,838	"
99	17198128	41,128	Townsend Reservoir
100	23428165	12,903	Sediment basin

(Continued)

(Sheet 4 of 6)

Table 01 (Continued)

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
101	24428139	4,032	Sediment basin
102	14548208	8,064	Reservoir
103	19228291	4,032	Sediment basin
104	20788268	62,096	"
105	23118219	17,741	Reservoir
106	16958375	4,838	Sediment basin
107	18128331	8,870	"
108	23598465	6,451	"
109	16748574	18,548	Reservoir
110	23258572	20,161	Sediment basin
111	19118630	4,838	Reservoir
112	19128629	2,419	"
113	06055765		Sediment basin
114	05685830		"
115	05605790		"
116	06585869		"
117	05605635		"
118	04555560		"
119	04685545		"
120	04755533		"
121	06465855		"
122	05036675		"
123	05436890		"
124	17906109		"
125	17386174		"
126	16806445		"
127	12845820		"

(Continued)

(Sheet 5 of 6)

Table 01 (Concluded)

Identification No.	Location (Military Coordinates)	Approximate Water Surface Area at Capacity, m^2	Type
128	10485775		Sediment basin
129	10085685		"
130	10905648		"
131	11465558		"
132	10705711		"
133	05505877		"
134	06055925		"
135	22737359		"
136	08546475		"
137	10235810		"
138	08126018		"
139	07435805		"
140	06075860		"
141	06145733		"
142	06425714		"
143	04055493		"
144	06095572		"
145	06155464		"
146	05915389		"

(Sheet 6 of 6)

Table 02

Locations and Storage Capacities of Downrange Wells*

Identification No.	Location (Military Coordinates)	Well Depth m	Storage Tank Capacity m^3	Stock Tank Capacity m^3	Comments
1	08145249	51		>1	Windmill
2	10545452	43	70	16	
3	08485514			46	
4	05905632	103	70	5	
5	21665645	85		30	
6	14355852				
7	03686019	53			
8	07196092	93	70	1	
9	05746193	96			
10	10966257				
11	09496479	72	70		
12	10626704	58	36	2	
13	05716888		40	2	
14	09897169	58	36	4	
15	20945438				Water tank (well with electric pump)
16	16775683				(well with electric pump)
17	15957397				(well with electric pump)
18	20498091				(well with electric pump)

* Blanks indicate no data.

Table 03

Surveyed Data on Forage Fields and Water Irrigation System at Fort Carson, Colorado

Survey Point	Coordinates, cm X	Y	Z	Comments
1	0.	0.	0.	TOP OF INFLOW PIPE
2	99999.00	0.	-231.00	
3	0.25	-2.99	-33.00	INVERT INTAKE PIPE
4	4.13	-49.83	-33.00	& BOX
5	-375.01	139.17	49.00	NATURAL GROUND
6	-335.96	-98.14	40.00	RT DITCH
7	-311.63	-159.33	1.00	& DITCH
8	-284.35	-204.07	32.00	LT TB DITCH
9	-233.61	-430.73	30.00	NATURAL GROUND
10	-1187.89	-170.06	44.00	NATURAL GROUND
11	-908.49	-417.91	31.00	TOE LEVEE
12	-885.21	-465.18	48.00	& LEVEE
13	-871.93	-509.74	20.00	TOE LEVEE RT TB DITCH
14	-842.17	-539.22	-4.00	& DITCH
15	-822.89	-576.96	21.00	TOE LEVEE LT TB DITCH
16	-791.22	-611.53	42.00	& LEVEE
17	-758.70	-651.44	24.00	TOE LEVEE
18	-606.93	-917.41	16.00	NATURAL GROUND
19	-5408.83	-2550.48	14.00	NATURAL GROUND
20	-5278.38	-2852.84	5.00	TOE LEVEE
21	-5250.55	-2883.03	18.00	& LEVEE
22	-5241.58	-2919.91	-2.00	TOE LEVEE RT TB DITCH
23	-5217.26	-2963.14	-23.00	& DITCH
24	-5202.70	-3008.65	0.00	TOE LEVEE LT TB DITCH
25	-5176.45	-3043.75	17.00	& LEVEE
26	-5150.71	-3077.37	-8.00	TOE LEVEE
27	-5034.62	-3444.22	-21.00	NATURAL GROUND
28	-479.70	4283.22	163.00	NATURAL GROUND NW COR FLD
29	-411.90	4521.28	93.00	& BOX NO 14
30	-480.24	4514.53	153.00	& DITCH IN THROAT OF BOX
31	-3335.95	1777.60	124.00	NATURAL GROUND RT BANK
32	-3473.95	1982.85	119.00	& DITCH
33	-6129.75	930.69	122.00	NATURAL GROUND RT BANK
34	-6216.46	1082.47	110.00	& DITCH
35	-9023.10	-1393.03	106.00	NATURAL GROUND RT BANK
36	-9229.82	-1219.21	97.00	& DITCH
37	-13694.07	-2910.75	92.00	NATURAL GROUND RT BANK
38	-13738.35	-2745.52	82.00	& DITCH
39	-12664.00	-6423.64	-21.00	NATURAL GROUND LT BANK

(Continued)

* Data obtained in June 1976.

(Sheet 1 of 3)

Table 03 (Continued)

Survey Point	Coordinates, cm X	Y	Z	Comments
40	-12645.33	-6569.48	-46.00	& DITCH
41	-12508.58	-6930.03	-42.00	NATURAL GROUND RT BANK
42	-11493.73	-11274.04	-189.00	NATURAL GROUND IN FLD
43	-7084.26	-8803.59	-181.00	NATURAL GROUND IN FLD
44	403.13	-4582.30	-131.00	OUTFLOW OF BOX NO 16
45	443.36	-4568.54	-177.00	& BOX NO 16
46	336.45	-4587.68	-117.00	NATURAL GROUND EDGE FLD
47	1839.60	-8809.99	-337.00	& BOX NO 17
48	1794.16	-8829.56	-290.00	OUTFLOW BOX NO 17
49	1570.95	-8760.26	-250.00	NATURAL GROUND RT BANK
50	1665.40	-8895.44	-298.00	& DITCH
51	1767.69	-9237.39	-264.00	NATURAL GROUND LT BANK
52	-1081.48	-10856.27	-302.00	NATURAL GROUND RT BK
53	-1079.97	-11047.34	-314.00	& DITCH
54	-1012.12	-11154.17	-312.00	NATURAL GR LT BK
55	-4763.67	-12471.16	-304.00	NATURAL GR RT BK
56	-4745.28	-12617.16	-326.00	& DITCH
57	-4646.84	-12781.51	-324.00	NATURAL GR LT BK
58	-9638.53	-15083.39	-316.00	NATURAL GR RT BK
59	-9578.49	-15239.83	-345.00	& DITCH
60	-9455.63	-15339.86	-327.00	NATURAL GR LT BK
61	-8464.26	-18561.15	-427.00	NATURAL GR IN FLD
62	-3193.26	-16086.12	-445.00	NATURAL GR IN FLD
63	3239.93	-13146.65	-407.00	NATURAL GR IN FLD
64	3310.79	-13201.16	-432.00	OUTFLOW BOX NO 18
65	3349.72	-13201.66	-483.00	& BOX NO 18
66	4802.44	-17461.63	-627.00	& BOX NO 19
67	4457.49	-17542.54	-556.00	NATURAL GR RT BK
68	-645.67	-19989.57	-588.00	NATURAL GR RT BK
69	-5686.96	-23316.48	-615.00	NATURAL GR RT BK
70	-19062.58	-16861.81	-323.00	NATURAL GR RT BK
71	-8918.37	-25245.17	-629.00	NATURAL GR RT BK DITCH 19
72	-14053.26	-26655.01	-643.00	NATURAL GR RT BK
73	-19151.43	-27671.45	-656.00	NATURAL GR RT BK
74	-29142.28	-28518.04	-678.00	NATURAL GR RT BK
75	-31837.47	-29113.02	-684.00	NATURAL GR RT BK
76	-35783.86	-29063.81	-704.00	NATURAL GR RTB SE CORNER
77	-36373.00	-25051.54	-582.00	SOUTH EDGE FLD
78	-37435.79	-19883.29	-395.00	NATURAL GR LT BK DITCH 17

(Continued)

(Sheet 2 of 3)

Table 03 (Concluded)

Survey Point	Coordinates, cm X	Y	Z	Comments
79	-37484.95	-19766.76	-409.00	& DITCH NO 17
80	-37472.08	-19653.69	-395.00	NATURAL GR RT BK DITCH 17
81	-38058.97	-16491.48	-270.00	SOUTH EDGE FLD .
82	-38721.79	-12219.04	-133.49	NATURAL GR LTB SW COR D15
83	-36920.54	-11147.28	-113.91	NATURAL GR LT BK DITCH 15
84	-37022.92	-11008.75	-128.84	& DITCH 15
85	-37098.21	-10917.40	-109.86	NATURAL GR RT BK DITCH 15
86	-37122.39	-10706.36	-111.16	WEST EDGE FLD
87	-34264.50	-10193.85	-113.74	NATURAL GR LT BK DITCH 15
88	-34299.44	-10026.02	-118.96	& DITCH 15
89	-34353.96	-9903.81	-101.85	NATURAL GR RT BK DITCH 15
90	-34448.12	-9630.97	-93.04	WEST EDGE FLD
91	-29433.90	-9445.74	-96.74	NATURAL GR LT BK DITCH 15
92	-29435.84	-9311.69	-108.07	& DITCH 15
93	-29449.76	-9212.21	-87.19	NATURAL GR RT BK DITCH 15
94	-29918.95	-7631.33	-34.18	WEST EDGE FLD LT BK 14
95	-30007.73	-7519.67	-43.90	& DITCH 14
96	-30014.21	-7511.85	-46.50	NATURAL GR RT BK DITCH 14
97	-24842.23	-5217.26	61.26	NATURAL GR RT BK DITCH 14
98	-24768.04	-5403.73	31.12	& DITCH 14
99	-24692.01	-5589.30	40.57	NATURAL GR LT BK DITCH 14
100	-23701.01	-8399.70	-71.94	NATURAL GR RT BK DITCH 15
101	-23664.11	-8493.51	-89.14	& DITCH 15
102	-23614.18	-8637.28	-85.29	NATURAL GR LT BK DITCH 15
103	-12746.31	-6894.63	-60.08	NATURAL GR LT BK DITCH 15
104	-9794.52	-15292.40	-330.00	NATURAL GR RT BK DITCH 17
105	-12572.92	-16794.80	-339.00	NATURAL GR RT BK DITCH 17
106	-12582.92	-16928.74	-366.00	& DITCH 17
107	-12485.50	-17057.98	-352.00	NATURAL GR LT BK DITCH 17

(Sheet 3 of 3)

APPENDIX P: HABITAT CHARACTERISTICS OF SELECTED PRAIRIE DOG TOWNS

1. Detailed environmental data were collected in seven prairie dog towns* on Fort Carson to establish the range of values for the environmental factors in those towns. The collection effort consisted of describing the physical characteristics of all burrows within a 100-m-diam cell. To start the characterization, a ground reconnaissance of the town was conducted to establish the general range of variation in soil, slope, vegetation, and burrow density in the town. After the reconnaissance, a center point for the 100-m-diam cell was established in an area of the town that appeared to be representative of the range of variation in those factors. A theodolite was set up (Figure P1) at

Figure P1. Theodolite setup in center of 100-m-diam cell. Stakes mark surveyed black-tailed prairie dog burrows

the center point, and an azimuth reference line (magnetic north) was established. Each burrow within the cell was located by distance and

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* The towns numbered 1-7 in this appendix correspond to towns numbered 1-7 in the text (see paragraph 31 and Figure 9 in the text).

azimuth, and the following physical attributes of the burrow were measured and recorded:

<u>a</u>. Mound height.

<u>b</u>. Mound diameter.

<u>c</u>. Burrow opening diameter.

<u>d</u>. Tunnel azimuth (upper 30 cm of tunnel).

<u>e</u>. Tunnel slope (upper 30 cm of tunnel).

Mound height, mound diameter, and burrow opening diameter were measured with a ruler (Figure P2a). Tunnel azimuth and slope were measured with a Brunton compass and stadia rod (Figure P2b). The ground elevation of each burrow and the ground slope of the cell were determined with the theodolite and stadia rod.

2. Figures P3-P9 show the locations of the prairie dog burrows within the seven sample cells (one for each of seven towns). The mean area per burrow was calculated by the following equation:

$$A_m = \frac{\pi R^2}{N} \tag{P1}$$

where

A_m = mean area per burrow, m^2

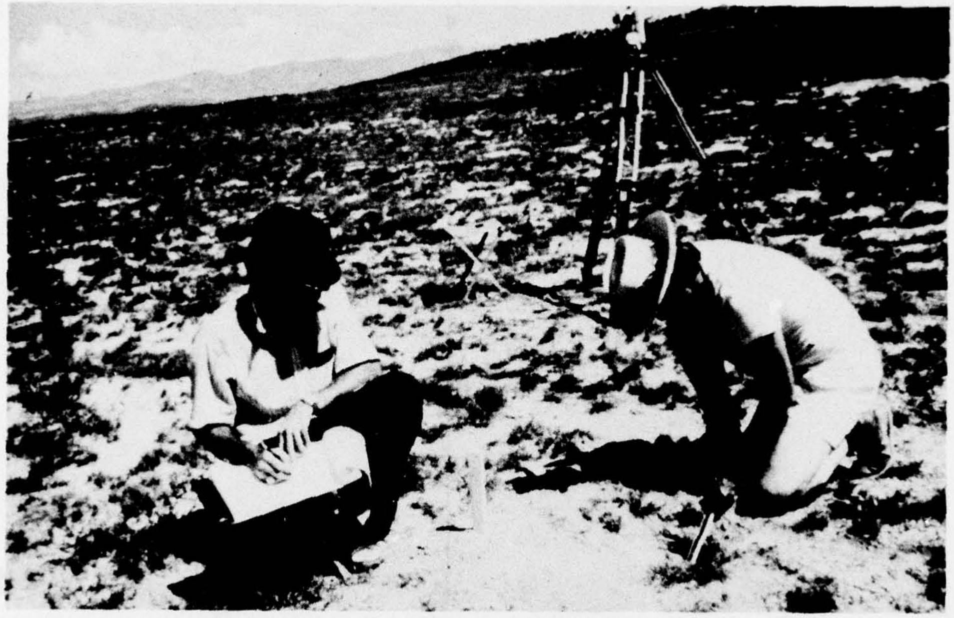
R = radius of sample cell, m

N = number of burrows within the cell

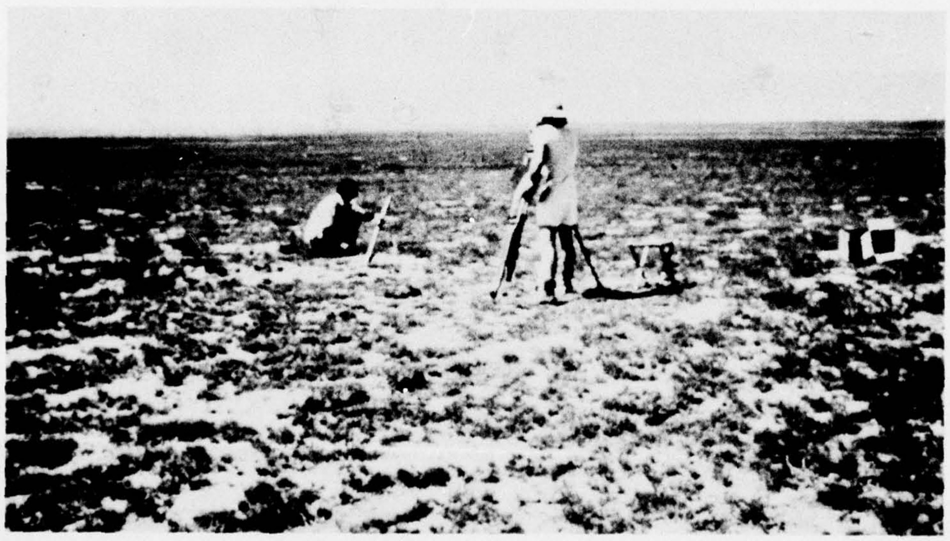
The mean area per burrow for the seven 100-m-diam sample cells varied between 116 and 192 m^2. The average mean area per burrow was determined to be 149 m^2 (Table P1).

3. The data describing the physical attributes of the burrows were further analyzed by calculating a mean and standard deviation for each set of burrow measurements. These measurements are tabulated in Table P1, together with the data on ground slopes and mean area per burrow values. Topographic elevation at the sample cell center was determined from USGS 1:50,000-scale topographic maps of Fort Carson.

4. A plot of mean tunnel azimuth versus terrain downslope azimuth (Figure P10) indicates that the azimuth of the opening of prairie dog



a. Measurement of mound height and tunnel diameter with ruler



b. Measurement of tunnel azimuth and slope with Brunton compass and stadia rod

Figure P2. Measurement of physical attributes of black-tailed prairie dog burrows

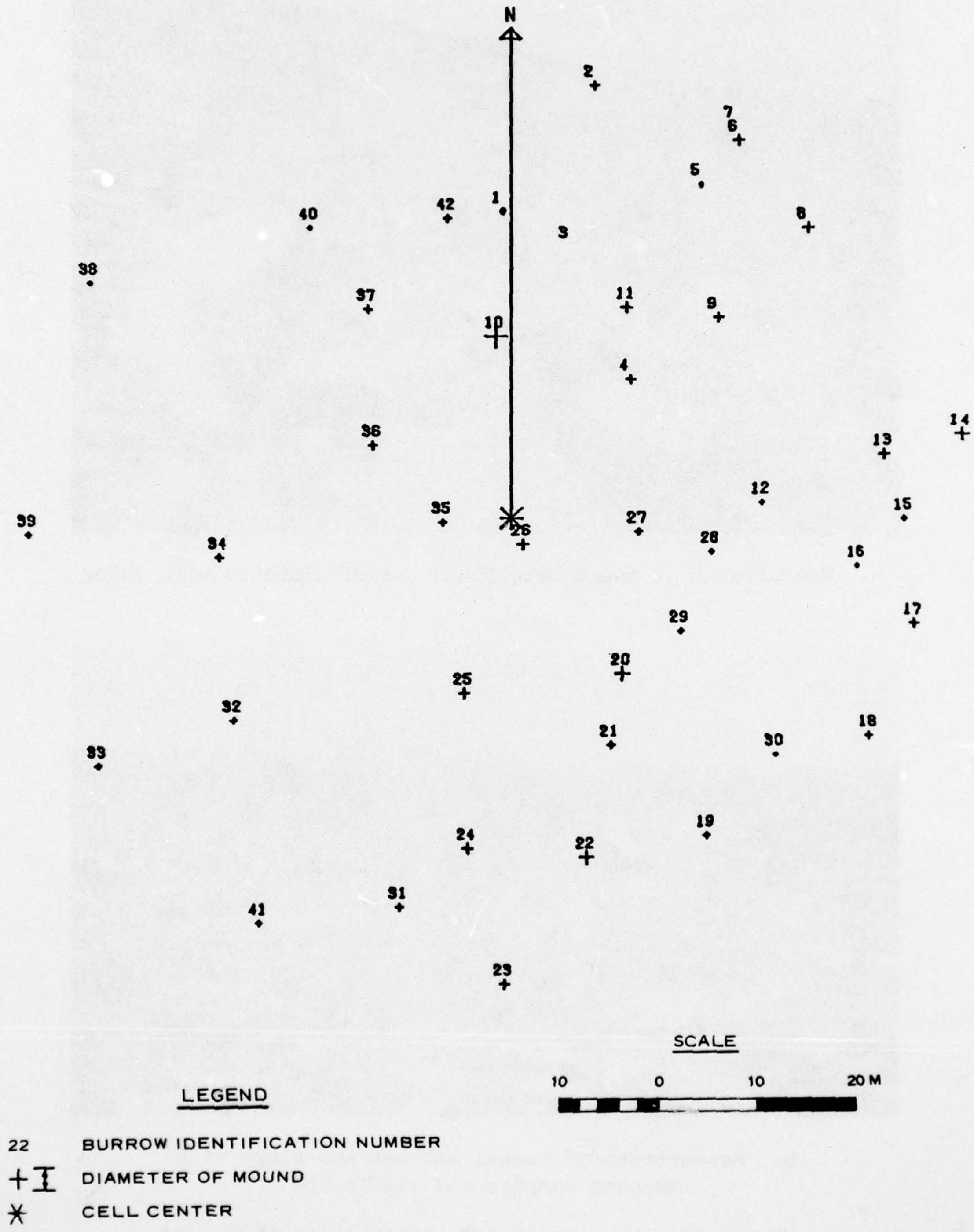


Figure P3. Distribution of prairie dog burrows in town 1, Fort Carson, Colorado

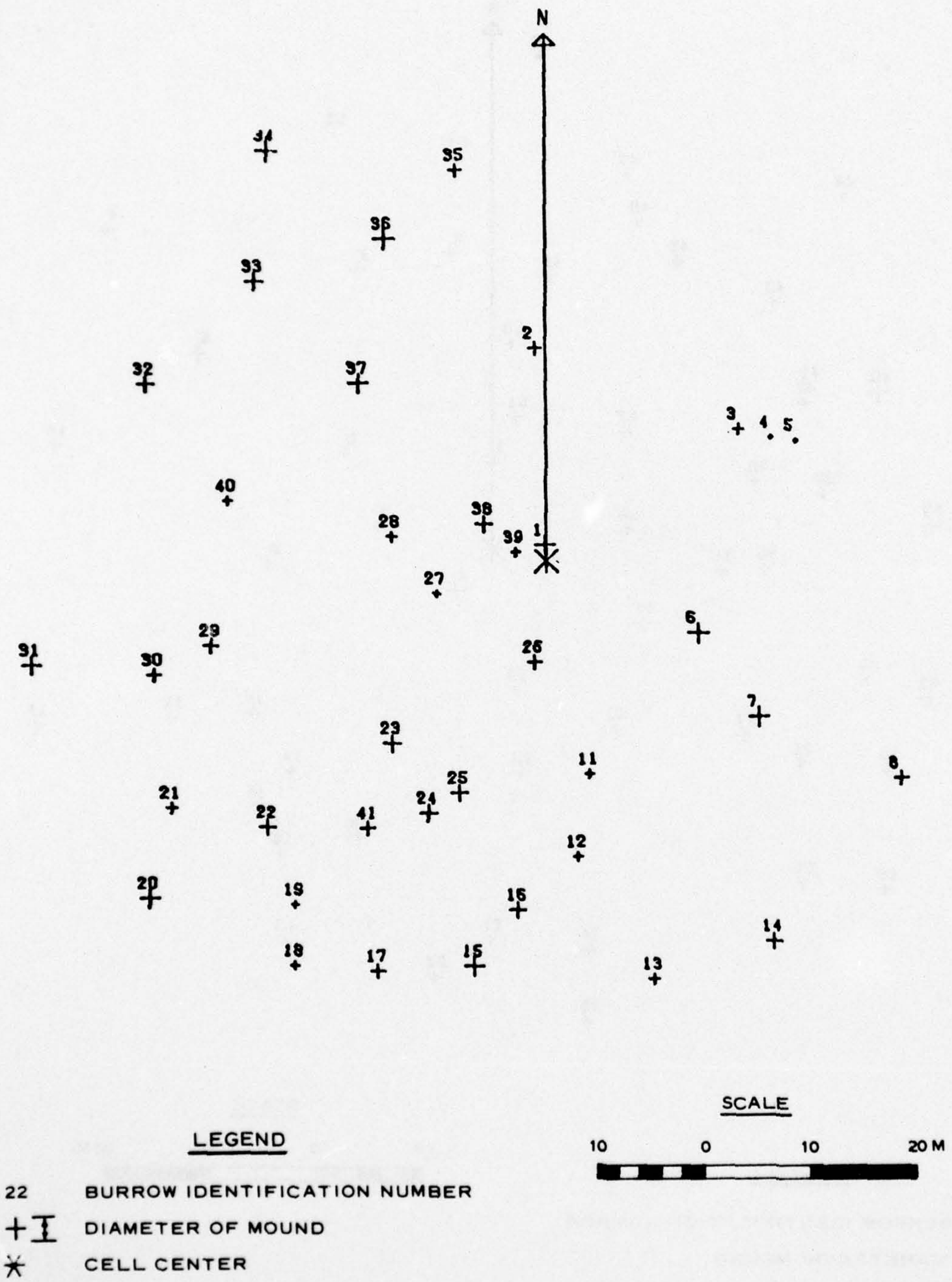


Figure P4. Distribution of prairie dog burrows in town 2, Fort Carson, Colorado

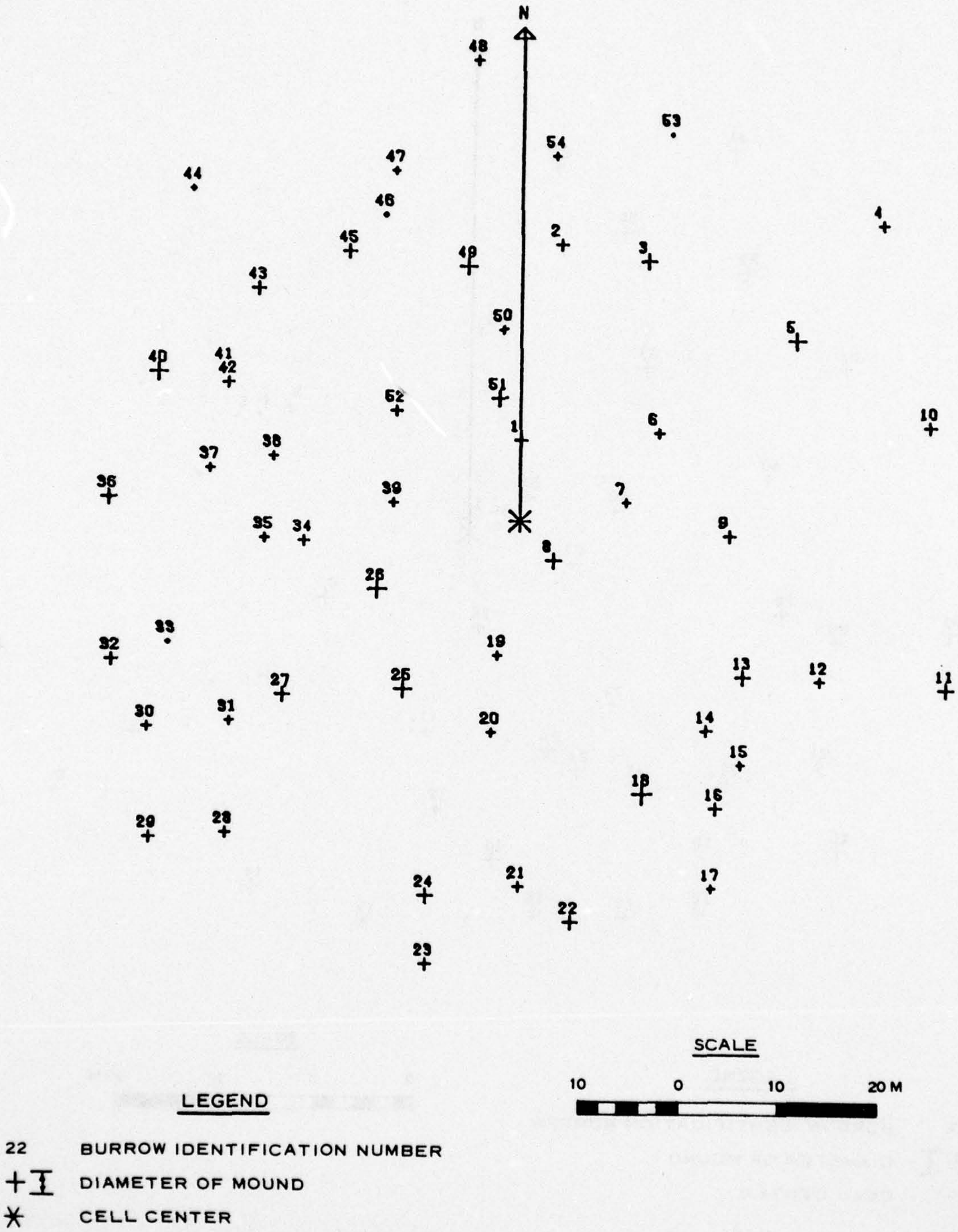


Figure P5. Distribution of prairie dog burrows in town 3, Fort Carson, Colorado

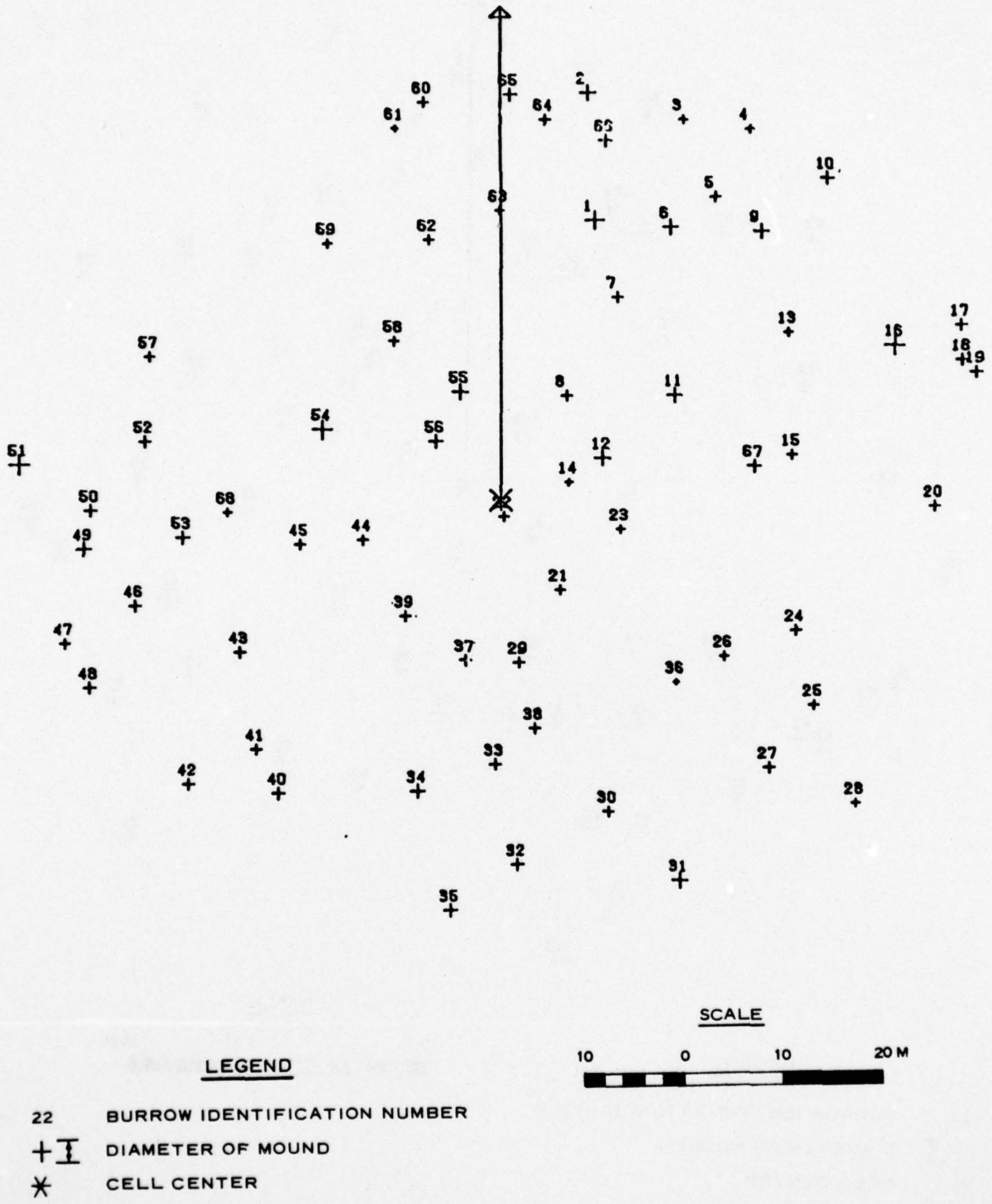


Figure P6. Distribution of prairie dog burrows in town 4, Fort Carson, Colorado

LEGEND

22 BURROW IDENTIFICATION NUMBER

+ I DIAMETER OF MOUND

✳ CELL CENTER

Figure P7. Distribution of prairie dog burrows in town 5, Fort Carson, Colorado

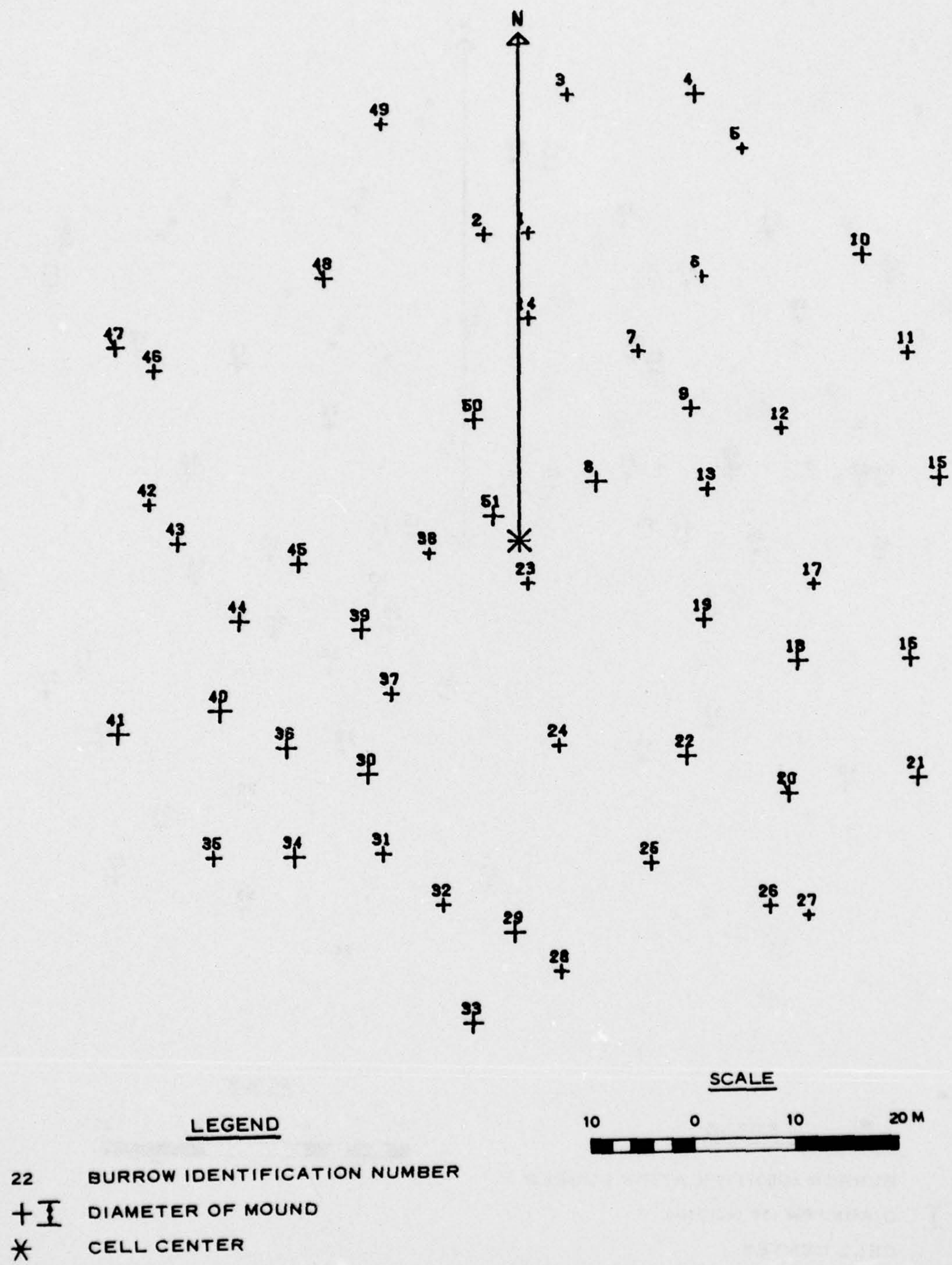


Figure P8. Distribution of prairie dog burrows in town 6, Fort Carson, Colorado

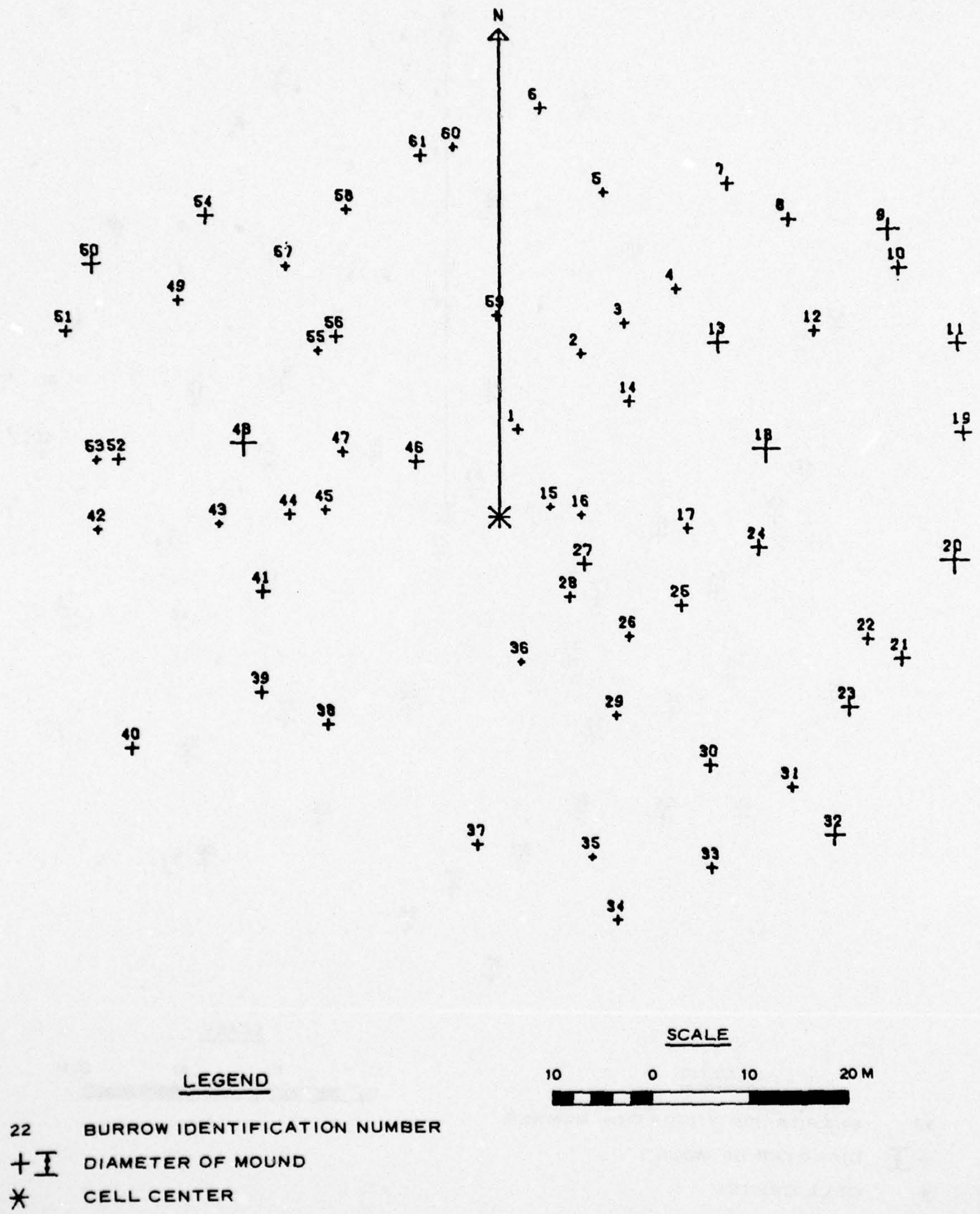


Figure P9. Distribution of prairie dog burrows in town 7, Fort Carson, Colorado

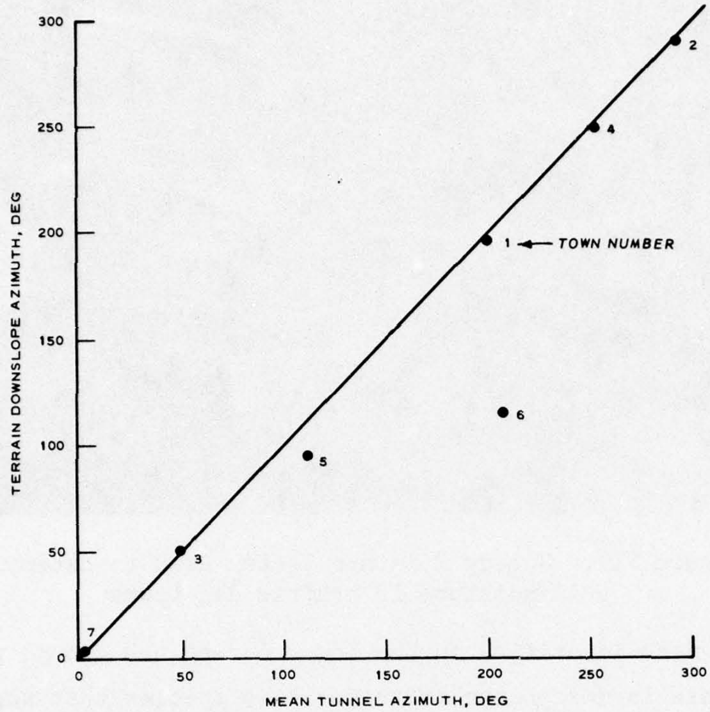


Figure P10. Mean tunnel azimuth versus terrain downslope azimuth, prairie dog towns 1-7, Fort Carson, Colorado

burrows are aligned along the direction of the downslope azimuth.

5. In addition to the data on the burrows within the cell, a bulk soil sample was taken for analysis of soil type. Also, soil moisture was measured at different depths with a Speedy Moisture Tester* (Figure P11). The soil data for the seven habitat areas are tabulated in Table P2.

6. The ground reconnaissance (see paragraph 1) indicated that perennial grasses were predominant in the towns and that wide variety of annual and perennial grasses, annual and perennial weeds, and some shrubs characteristic of the short- and mixed-grass prairie occurred within the towns. However, these weeds and shrubs occurred only in low numbers or in small concentrated patches. Table P3 lists all the

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* Manufactured by Thomas Ashworth and Co., LTD. Burnley, England.

Figure P11. Speedy Moisture Tester used to determine soil moisture in prairie dog towns

species that were identified in the towns during the ground reconnaissance and ranks in descending order the five species that appeared to have the greatest densities in each town. A comparison between this list of species (Table P3) and the list of species reported to be forage of the prairie dog (Table D2) indicates that from 33 to 64 percent of the plant species in the towns are forage of the prairie dog (Table P4).

7. Vegetation data collection in the prairie dog towns consisted of establishing a representative 2- by 2-m sample plot within each 100-m-diam cell. Since the predominant vegetation in all towns except town 3 was the grasses (the main forage of the prairie dog), only one sample plot was established in those towns. Two sample plots were established in town 3 because approximately 50 percent of the soil surface in that town had been disturbed during the construction of a drainage ditch: a grass predominated in the undisturbed soil, while an annual weed predominated in the disturbed soil.

8. Within each sample plot, the following baseline data were obtained:

a. Species.

b. Plant density (number of each species).

c. Ground area covered.

d. Height range.

e. Average height.

Plant density for all species except grasses was determined by counting the number of individual plants in the entire 2- by 2-m plot. Plant density of grasses was calculated by counting the number of stems of each grass within a 20- by 20-cm subsample plot (one percent of the area of the 2- by 2-m plot) and multiplying the number obtained by 100 to derive the density for the whole 2- by 2-m plot. Ground area covered and minimum and maximum height (height range) were measured. Average height of the vegetation was estimated.

9. Table P5 presents the detailed vegetation data obtained within the 2- by 2-m plots. Figure P12 shows the total plant density and ground coverage for the sample plots after the density and ground coverage of each species in the plots were summed. It should be noted that the variety of species in the sample plots (Table P5) is less than the variety of species in the town (Table P3). This is due to the fact that the sample plots were established to determine the density, ground area covered, and heights of the predominant vegetation. The vegetation data were not intended to be representative of all the vegetation in the towns.

10. The data collection effort discussed in paragraphs 1-9 indicate that the following environmental factors occurred within the seven existing towns:

a. Elevation: 1682-1951 m (Table P1)

b. Slope: 0-4.5 deg (Table P1)

c. Vegetation type: short- and mixed-grass prairie species (Table P3)

d. Vegetation height: 2-60 cm (Table P5)

e. Vegetation cover: 10-40 percent (Table P5)

f. Soil type: Silty clay and sandy clay (Table P2)

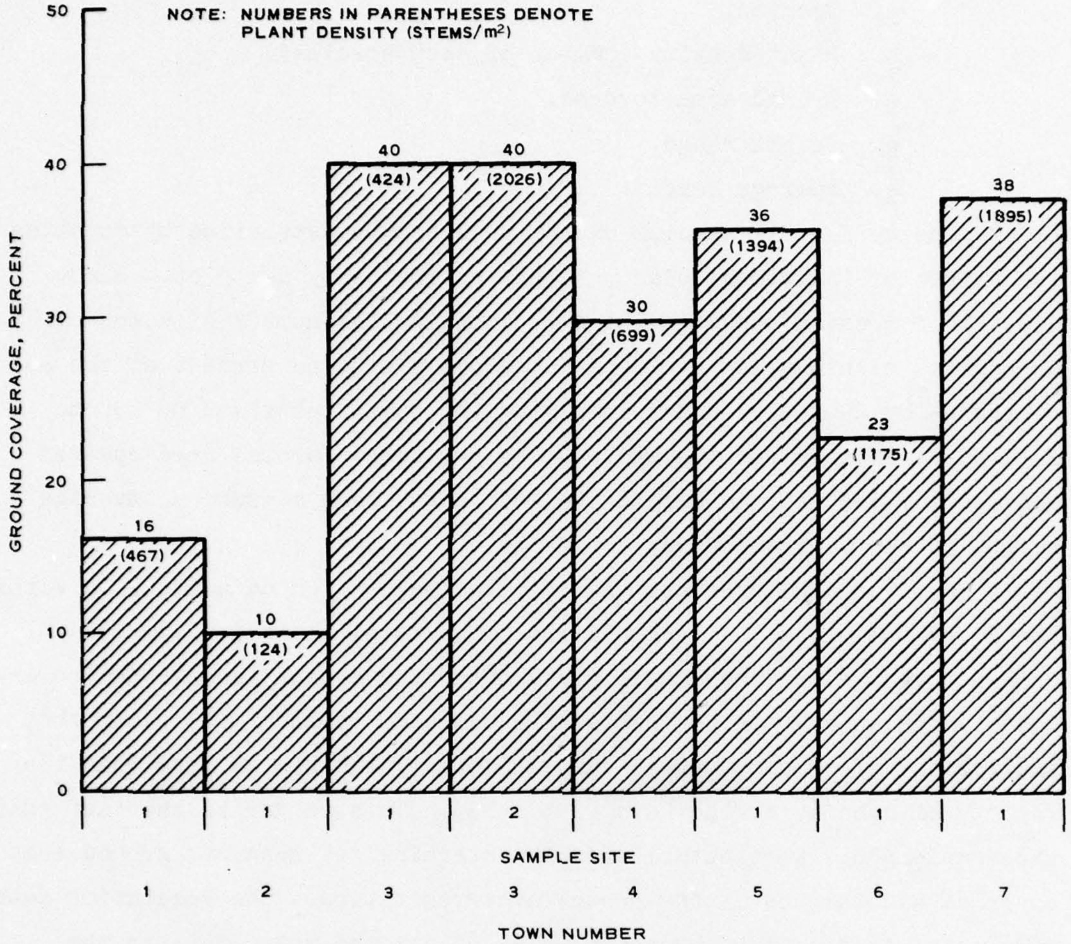

Figure P12. Total plant density and ground coverage of nonwoody vegetation in sample plots in prairie dog towns 1-7, Fort Carson, Colorado

These values, when compared to the range of values for the same environmental factors in the literature, were within the range of values reported in that literature.

Table P1

Data Collected Within 100-m-Diam Cell in Prairie Dog Towns 1-7, Fort Carson, Colorado

Town	Number of Burrows Within Cell	Mound Height, cm		Mound Diameter cm		Burrow Opening Diameter cm		Tunnel Slope deg**		Tunnel Azimuth deg**	Ground Slope deg	Downslope Azimuth deg**	Mean Area per Burrow m^2	Elevation m
		x*	σ*	x	σ	x	σ	x	σ	x				
1	42	7.0	5.0	71	41	10	2	30	4	186	1	190	187	1670
2	41	13.0	7.0	127	47	12	3	36	6	286	2	281	192	1728
3	54	11	6	107	41	11	3	32	9	51	1	50	145	1682
4	68	13	5	111	31	11	2	32	7	254	4.5	249	116	1768
5	67	15	10	131	36	12	3	34	10	124	2.5	90	117	1951
6	51	20	7	147	29	12	2	37	77	217	1	130	154	1939
7	61	15	7	121	50	11	2	29	6	3	1.5	3	129	1768
Average	55	13	7	116	39	11	2	33	7	160	1.9	141	149	1786

* x = mean; σ = standard deviation.
** North = 0° azimuth.

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Table P2

Soil Data Collected in Prairie Dog Towns 1-7, Fort Carson, Colorado

Town Identification No.	Soil Moisture: Depth Range Sampled, cm	Soil Moisture: Moisture Content, Percent of Dry Weight	Visual Description of 0- to 15-cm Bulk Sample
1	0-7.5	8.8	Light brown silty clay (CL) with traces of sand and gravel
	7.5-30	7.5	
2	0-5	2.1	Brown silty clay (CL) with trace of gravel
	5-15	5.6	
3	0-5	2.8	Light brown silty clay (CL) with trace of gravel to 6-mm diameter
	5-15	7.6	
4	0-15	3.0	Light brown silty clay (CL) with trace of gravel to 12-mm diameter
5	0-5	3.4	Reddish-brown silty clay (CL)
	5-15	5.9	
6	0-5	2.2	Reddish-brown sandy clay (CL) with trace of gravel
	5-15	4.2	
7	0-5	8.3	Light brown silty clay (CL) with fine to coarse sand
	5-15	10.2	

Table P3

Plant Species Identified in Prairie Dog Towns, Fort Carson, Colorado

Scientific Name	Common Name
Prairie Dog Town 1	
Aristida longiseta	Red three awn
Aster tanacetifolius	Aster
Bouteloua curtipedula	Side oats grama
Bouteloua gracilis[2]	Blue grama
Chenopodium album	Lambsquarters
Conyza canadensis	Mare's tail
Cucurbita foetidissima	Wild gourd
Dyssodia papposa	Fetid marigold
Gaillardia pulchella	Gallardia
Helianthus annulus[5]	Sunflower
Opuntia arborescens	Cholla
Opuntia polycantha	Prickley pear
Salsola kali[1]	Russian thistle
Schedonnardus paniculatus	Tumblegrass
Scleropogon brevifolius[4]	Burro grass
Sitanion hystrix	Bottle brush squirreltail
Sphaeralcea coccinea	Scarlet globe mallow
Sporobolus cryptandrus[3]	Sand dropseed
Verbena bracteata	Verbena
Prairie Dog Town 2	
Aristida longiseta[3]	Red three awn
Atriplex canescens	Four winged saltbush
Dyssodia papposa[2]	Fetid marigold
Gutierrezia sarothrae	Snakeweed
Haplopappus fremontii	Fremont's goldenweed
Helianthus annulus	Sunflower
Kochia scoparia	Kochia
Linum Lewisii	Blue flax
Muhlenbergia asperifolia[5]	Scatch grass muhly
Muhlenbergia torreyi	Ring muhly

(Continued)

Note: Superscripts rank in descending order the five species having the greatest densities in each prairie dog town.

(Sheet 1 of 4)

Table P3 (Continued)

Scientific Name	Common Name
Prairie Dog Town 2 (Continued)	
Oryzopsis hymenoides	Indian ricegrass
Salsola kali[1]	Russian thistle
Sitanion hystrix	Bottle brush squirreltail
Solidago missouriensis	Goldenrod
Sphaeralcea coccinea	Scarlet globe mallow
Stipa robusta	Sleepy needlegrass
Tridens pilosus[4]	Hairy tridens
Verbena bracteata	Verbena
Prairie Dog Town 3	
Bouteloua gracilis[2]	Blue grama
Chenopodium album[1]	Lambsquarters
Dyssodia papposa	Fetid marigold
Eurotia lanata	Winterfat
Euphorbia marginata	Snow-on-the-mountain
Helianthus annulus	Sunflower
Kochia scoparia[3]	Kochia
Opuntia arborescens	Cholla
Opuntia polycantha	Prickly pear
Physalis lobata	Ground cherry
Salsola kali[4]	Russian thistle
Sitanion hystrix	Bottle brush squirreltail
Sporobolus cryptandrus[5]	Sand dropseed
Yucca glauca	Soapweed
Prairie Dog Town 4	
Alyssum alyssoides	Alyssum
Aristida longiseta[3]	Red three awn
Chenopodium album[4]	Lambsquarters
Dyssodia papposa	Fetid marigold
Eurotia lanata	Winterfat
Evolvulus nuttallianus	Nuttalls evolvulus
Haplopappus spinulosus	Goldenweed
Helianthus annulus[2]	Sunflower
Kochia scoparia	Kochia
Linum lewisii	Blue flax
Mentzelia oligosperma	Stick-leaf-mentzelia

(Continued)

(Sheet 2 of 4)

Table P3 (Continued)

Scientific Name	Common Name
Prairie Dog Town 4 (Continued)	
Muhlenbergia torreyi[5]	Ring muhly
Opuntia arborescens	Cholla
Opuntia polycantha	Prickley pear
Plantago purchii	Wolly plantain
Salsola kali[1]	Russian thistle
Solanum triflorum	Cutleaf nightshade
Sphaeralcea coccinea	Scarlet globe mallow
Tragopogon dubius	Goatsbeard
Tridens pilosus	Hairy tridens
Verbena bracteata	Verbena
Yucca glauca	Soapweed
Prairie Dog Town 5	
Aristida longiseta	Red three awn
Bouteloua gracilis[1]	Blue grama
Eurotia lanata[3]	Winterfat
Helianthus annulus	Sunflower
Opuntia polycantha	Prickley pear
Physalis lobata	Ground cherry
Plantago purchii	Wooly plantain
Salsola kali[5]	Russian thistle
Sphaeralcea coccinea[2]	Scarlet globe mallow
Sporobolus cryptandrus[4]	Sand dropseed
Stipa robusta	Sleepy needlegrass
Prairie Dog Town 6	
Cirsium vulgare	Bull thistle
Cucurbita foetidissima	Wild gourd
Dyssodia papposa[1]	Fetid marigold
Eurotia lanata	Winterfat
Helianthus annulus	Sunflower
Kochia scoparia[2]	Kochia
Linum lewisii	Blue flax
Melilotus alba	White sweet clover
Physalis lobata[5]	Ground cherry
Plantago purchii	Wooly plantain
Psoralea tenuiflora	Wild alfalfa
Salsola kali[4]	Russian thistle

(Continued)

(Sheet 3 of 4)

Table P3 (Concluded)

Scientific Name	Common Name
Prairie Dog Town 6 (Continued)	
Schedonnardus paniculatus[3]	Tumblegrass
Sphaeralcea coccinea	Scarlet globe mallow
Verbena bracteata	Verbena
Prairie Dog Town 7	
Ascelepias subverticillata	Milkweed
Aster tanacetifolius	Aster
Bouteloua gracilis[1]	Blue grama
Chenopodium album	Lambsquarters
Dyssodia papposa[5]	Fetid marigold
Eurotia lanata	Winterfat
Kochia scoparia	Kochia
Muhlenbergia torreyi[4]	Ring muhly
Opuntia polycantha	Prickley pear
Salsola kali[3]	Russian thistle
Schedonnardus paniculatus[2]	Tumblegrass
Sphaeralcea coccinea	Scarlet globe mallow

(Sheet 4 of 4)

Table P4

Percent of Plant Species Identified in Prairie Dog Towns 1-7 That Are Forage of the Prairie Dog

Town Identification No.	Total Number of Species in Town*	Total Number of Species in Town That Were Reported to be Forage of the Prairie Dog**	Species in Towns That Are Forage of the Prairie Dog, %
1	19	8	42
2	18	6	33
3	14	9	64
4	22	9	41
5	11	7	64
6	15	5	33
7	12	7	58
AVERAGE	16	7	48

* Table P3.
** Table D2.

Table P5

Vegetation Data Collected in Sample Plots in Prairie Dog Towns 1-7, Fort Carson, Colorado

Scientific Name	Common Name	Estimated Number of Stems Per m^2	Ground Area Covered, %	Height Range cm	Average Height cm
	Prairie Dog Town 1				
Bouteloua gracilis	Blue grama	445	10	5-20	7
Salsola kali	Russian thistle	10	5	10-30	19
Chenopodium album	Lambsquarters	8	1	5-20	8
	Prickley pear	4	<1	5-20	10
	TOTAL	467	16		
	Prairie Dog Town 2				
Salsola kali	Russian thistle	17	10	10-30	15
Dyssodia papposa	Fetid marigold	60	<1	5-15	8
Sphaeraicea coccinea	Scarlet globe mallow	7	<1	5-15	10
Muhlenbergia asperifolia	Scratch grass muhly	40	<1	2-10	5
	TOTAL	124	10		
	Prairie Dog Town 3 Sample 1 (near graded ditch)				
Chenopodium album	Lambsquarters	182	35	5-20	15
Bouteloua gracilis	Blue grama	242	5	5-15	8
	TOTAL	424	40		
	Prairie Dog Town 3 Sample 2 (undisturbed soil surface)				
Bouteloua gracilis	Blue grama	2024	40	5-20	15
Chenopodium album	Lamsquarters	2	<1	5-20	10
	TOTAL	2026	40		

(Continued)

Table P5 (Concluded)

Scientific Name	Common Name	Estimated Number of Stems Per m^2	Ground Area Covered, %	Height Range cm	Average Height cm
	Prairie Dog Town 4				
Salsola kali	Russian thistle	30	17	15-50	25
Muhlenbergia torreyi	Ring muhly	572	13	5-15	10
Chenopodium album	Lambsquarters	5	<1	10-25	15
Dyssodia papposa	Fetid marigold	90	<1	5-15	7
Helianthus annulus	Sunflower	2	<1	40-60	50
	TOTAL	699	30		
	Prairie Dog Town 5				
Bouteloua gracilis	Blue grama	1320	30	2-10	5
Eurotia lanata	Winterfat	70	5	5-15	10
Plantago purchii	Wooly plantain	4	1	5-10	7
	TOTAL	1394	36		
	Prairie Dog Town 6				
Dyssodia papposa	Fetid marigold	750	15	4-10	6
Schedonnardus paniculatus	Tumblegrass	420	7	2-10	6
Kochia scoparia	Kochia	5	1	20-40	30
	TOTAL	1175	23		
	Prairie Dog Town 7				
Bouteloua gracilis	Blue grama	1774	35	5-20	10
Salsola kali	Russian thistle	10	2	10-30	15
Muhlenbergia torreyi	Ring muhly	100	1	5-10	8
Chenopodium album	Lambsquarters	6	<1	5-20	10
Kochia scoparia	Kochia	5	<1	10-20	12
	TOTAL	1895	38		

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Rekas, Anthony M B
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